

SAMPLING AND ANALYSIS OF PERCHLORATE IN FERTILIZER

(Revision 3)

Prepared for

Perchlorate Study Group

Shreveport, Louisiana

Prepared by

TRC

Irvine, California

Participating Laboratories

American Pacific Corporation - Utah
Del Mar Analytical - California
Montgomery Watson Laboratories - California
Thiokol Corporation - Utah
Air Force Research Laboratory - Wright Patterson AFB, Ohio
United States EPA National Exposure Research Laboratory
Ecosystems Research Division - Georgia
United Technologies Corporation - California

July 1999

TRC

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Irvine, California

Project No. 98-346

July 1999

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1.0 INTRODUCTION AND BACKGROUND

1. The presence of naturally-occurring perchlorate has been identified in sodium- and potassium-nitrate mined from caliche deposits in Chile (i.e., in Chilean saltpeter). Chilean saltpeter is used as a nitrate fertilizer throughout the world. Schilt⁽¹⁾ describes observations of perchlorate in Chilean saltpeter as far back as 1896, with concentrations ranging from trace amounts to just under 7 percent. Levels of perchlorate of 1 to 1.5 percent in refined and crude Chilean saltpeter, respectively, measured in 1914 were also described (Schilt, 1979). A study in 1972 attributed poor soybean growth to elevated concentrations of perchlorate in Chilean nitrate fertilizer. The relatively broad range of perchlorate in Chilean saltpeter concentrations was attributed to varying degrees of the liquid recycling during the production of the nitrate salts, and the possible nonuniform distribution of naturally-occurring perchlorate in the caliche. Review of available literature and recent limited testing of selected samples of chemical fertilizer indicate the presence of perchlorate.
2. Based on the above-referenced literature, data and the results of the limited fertilizer sampling and analysis of California fertilizers for perchlorate conducted in August of 1998, additional studies were performed to determine if perchlorate is typically present in nitrate type fertilizers. In order to confirm the above results and also to obtain more information on the presence of perchlorate associated with the use of fertilizers, the following activities were completed, and are presented in this report:
 - Confirmatory sampling and analysis of previously tested products.
 - Collection and analysis of fertilizers nationwide.
 - Collection and analysis of fertilizer raw materials.

2.0 SAMPLING AND ANALYSIS

2.1 SAMPLE COLLECTION

1. To confirm the results of the recent limited perchlorate analysis results indicated above, samples were obtained from different production lots of previously tested California fertilizers. These samples were purchased from various commercial suppliers and retail sources.

⁽¹⁾ Schilt, Alfred, "Perchlorate Acid and Perchlorates, Fredrick Smith Chemical Company," 1979.

2. To obtain information on the potential presence of perchlorate associated with the use of chemical fertilizers, additional samples were collected from the Kansas City, Missouri and Long Island, New York areas. Samples of the fertilizers shown in Table 1 were collected from various commercial suppliers and retail sources.
3. Also, as part of this study, samples of two raw materials used in chemical fertilizer production were also collected. Caliche (Chilean nitrate) was obtained from the Aconcagua Nitrate Mine in Calama, Chile by TRC. A langbeinite (a potassium/magnesium sulfate mineral) ore sample (crushed) was provided by IMC Minerals in Albuquerque, New Mexico.
4. The fertilizers and raw material samples were collected under chain-of-custody procedures and forwarded to the primary laboratory for analysis.
5. The primary laboratory prepared extracts of each sample, which were then shipped to six outside laboratories for confirmatory analysis.

2.2 ANALYSIS

2.2.1 ION-CHROMATOGRAPHY

1. The primary laboratory (Del Mar Analytical, Irvine, California) analyzed the fertilizers using the California Department of Health Services (DHS) Method of Ion-Chromatography for Perchlorates (see Attachment 1). Table 1 provides a summary of the Ion-Chromatography perchlorate results.⁽²⁾
2. As discussed above, six outside laboratories analyzed the perchlorate extracts for confirmation purposes. However, these laboratories did not all perform the analyses using the California DHS Method for perchlorates. Table 2 provides a list of the methods used by each laboratory and the differences between the method used and the California DHS Method.
3. Table 1 provides a summary of the results of the analyses conducted by the outside laboratories discussed above. As noted in Table 1, the outside laboratories analyzed a 1:10 extract. The results in Table 1 for the outside laboratories were adjusted by a factor of ten to allow comparison with the primary laboratory data. Copies of the laboratory reports are provided in Appendix A.

⁽²⁾ Perchlorate sample analyses results from the United States Environmental Protection Agency were not yet available at the time of publishing this report. The report will be updated when USEPA results become available.

2.2.2 TRIPHENYLSTIBONIUM TITRATION

1. As part of this study, one set of the fertilizer extracts and various control samples prepared by TRC were analyzed using the triphenylstibonium titration method after purification of the extracts using ion exchange resin adsorption. The purpose of performing the titration study was to chemically confirm the presence of perchlorate in the extracts. The triphenylstibonium titration method has been shown to be highly specific for perchlorate, and therefore can be used to confirm the Ion-Chromatography results, which are highly accurate, but may be less specific in detecting perchlorate. Table 1 also includes a summary of the triphenylstibonium titration results.

3.0 DISCUSSION

1. The results of the sampling and analysis of the fertilizers indicated that perchlorate was present at varying levels in approximately 27 out of the 28 fertilizers tested (i.e., 96 percent). Please note that four fertilizer samples were analyzed in duplicate, thus there are 32 entries on Table 1. Raw materials samples, caliche and langbeinite ore, tested positive for perchlorate. The detectable perchlorate levels in these fertilizers ranged from approximately 2 parts per million (ppm) to over 11,000 ppm with most being greater than 500 ppm. The perchlorate concentration averaged roughly one-half of one percent (0.5 percent or 5,000 ppm), as measured in the 27 fertilizers that were positive for perchlorate. These results indicate that perchlorate levels can vary significantly between fertilizer brands and formulation types.
2. The results of the analysis of different production lots of the previously tested fertilizers showed significant variations between the different lots, indicating either variations in production practices or perchlorate levels in the raw materials. Both raw materials tested, caliche and langbeinite, contained elevated levels of perchlorate; 29,000 ppm and 15,000 ppm (i.e., 2.9 and 1.5 percent), respectively.
3. A comparison of the perchlorate results from the primary laboratory and the outside laboratories shows an excellent correlation. As indicated in Table 1, the standard deviations are very low, indicating a high level of precision. Table 1 also indicates the various duplicate samples and their results. The duplicate samples were found to generally agree within normal laboratory limits (i.e., ± 50 percent), with the exception of one duplicate sample PS-17/PS-24 which showed an unexplained significant difference. This difference is most likely due to an error in the extract preparation, since all of the laboratories had similar results for these samples.

4. The results of the triphenylstibonium titration appear to generally agree with the ion-chromatography results, although the method appears to slightly over estimate the perchlorate levels. Quality control samples submitted to the laboratory containing known levels of perchlorate, chlorate, chlorite, ammonium nitrate and thiosulfate showed no interference with the perchlorate analysis. Additional duplicate samples submitted also showed good correlation, within the expected limits.

TABLES

TABLE 1
FERTILIZER PERCHLORATE LIQUID CHROMATOGRAPHY TESTING PRELIMINARY RESULTS

	MANUFACTURER	BRAND NAME	N-P-K ⁽¹⁾ RATIO	PRIMARY CONSTITUENT	TRIPHENYL- STIBONIUM TITRATION (mg/kg) ⁽¹⁾	ION- CHROMATO- GRAPHY DEL MAR ANALYTICAL RESULTS (mg/kg)	SPLIT SAMPLE ANALYSIS RESULTS (mg/kg) ⁽¹¹⁾						STATISTICAL EVALUATION		PERCENTAGE OF PERCHLORATE (%)
							LAB 1	LAB 2	LAB 3	LAB 4	USAF	USEPA ⁽¹⁴⁾	MEAN ⁽¹²⁾	STANDARD DEVIATION ⁽¹³⁾	
Obtained 1/27/99 Kansas City, Missouri															
PS-11	Scott's	Miracle-Gro Lawn Food	36-6-6	Potash derived from Potassium Nitrate	8,600	7,400	8,160	6,260	8,800	8,290	7,068		7,663	930	0.77
PS-13	Shultz	Rose Plus	19-24-24	Potassium Nitrate	<50	13	<6.0	<40	<0.8	9.6	00		9.2	8	0.0009
PS-10	Acme	Stump Remover	NA	Potassium Nitrate	<50	<0.4	<6.0	<40	<0.4	<3.0	00		4.98	8	<0.0003
PS-07	Sudbury	Potash	0-0-44	Potassium Chloride	5,440	4,800	4,730	8,830	5,000	4,920	4,369		5,442	1,674	0.54
PS-05	Peters	All Purpose Plant Food	20-20-20	Potassium Nitrate	7,150	6,300	6,700	4,760	6,200	6,360	6,898		6,203	754	0.62
PS-14	Jobe's	Plant Food Spikes	16-2-6	Potassium Nitrate	10,350	8,100	9,480	8,640	9,000	9,920	6,896		8,673	1,077	0.87
PS-01	Fertilome	Start-N-Grow Plant Food	18-6-12	Potassium Nitrate	5,900	4,700	4,680	5,150	5,300	4,710	4,872		4,902	264	0.49
PS-08	Osmocote	Vegetable and Bedding Plant Food	14-14-14	Ammonium Nitrate	1,250	940	1,090	968	970	1,010	803		964	94	0.09
PS-12 ⁽⁴⁾	Osmocote	Vegetable and Bedding Plant Food	14-14-14	Ammonium Nitrate	750	540	636	597	530	580	526		568	44	0.06
PS-02	Ringer	Supreme Gardens	7/7/07	Nitrate of Soda	2,950	3,200	3,490	2,360	3,100	3,240	3,077		3,078	381	0.31
PS-09 ⁽⁵⁾	Ringer	Supreme Gardens	7/7/07	Nitrate of Soda	5,200	3,900	4,380	5,120	4,300	4,380	4,049		4,355	422	0.44
PS-03	Peters	Lawn Food	38-4-4	Potassium Nitrate	9,900	8,600	8,950	7,730	9,400	8,860	7,678		8,536	695	0.85
PS-04	HiYield	Nitrate of Soda	16-0-0	Nitrate of Soda	6,800	7,400	7,620	6,300/11,840 ⁽¹⁶⁾	8,000	7,660	6,908		7,637	761	0.76
Obtained 1/28/99 Long Island, New York															
PS-15	Ringer	Lawn Restorer	10/2/06	Nitrate of Soda	6,140	5,300	6,060	5,190	6,100	6,080	4,673		5,567	600	0.56
PS-21 ⁽⁶⁾	Ringer	Lawn Restorer	10/2/06	Nitrate of Soda	3,400	2,400	2,960	2,560	2,900	3,000	2,376		2,699	287	0.27
PS-20	Frank's	Grow	15-30-15	Muriate of Potash	6,250	5,400	5,380	10,000	4,800	5,560	7,098		6,373	1,936	0.62
PS-16	Peters	All Purpose Plant Food	20-20-20	Potassium Nitrate	6,980	7,300	7,510	5,640	7,400	7,210	6,194		6,876	770	0.7
PS-19	Osmocote	Vegetable and Bedding Plant Food	14-14-14	Ammonium Nitrate	3,100	2,500	2,650	3,270	2,700	2,660	2,053		2,639	391	0.26
PS-18	Osmocote	Outdoor and Indoor Plant Food	18-6-12	Ammonium Nitrate	740	600	733	832/993 ⁽¹⁶⁾	750	690	904		765	255	0.08
PS-23	Vigoro	Tomato and Vegetable Plant Food	10/8/14	Muriate of Potash, Sul Po Mag	450	360	464	738	340	430	514		474	144	0.05
PS-17	Jonathan Green	Fall Fertilizer	10/18/20	Muriate of Potash	<50	<0.4	<6.0	<40	2.2	<3.0	00		5.3	8	0.0005
PS-24 ⁽⁷⁾	Jonathan Green	Fall Fertilizer	10/18/20	Muriate of Potash	2,850	2,400	2,590	2,840	2,200	2,480	2,530		2,507	212	0.25
PS-22	Scotts	Miracle-Gro Lawn Fertilizer	31-3-9	Muriate of Potash	1,700	1,300	1,549	2,646	1,400	1,530	1,995		1,737	505	0.17
Obtained from California Source															
PS-31	CNC ⁽⁸⁾	Champion Potassium Nitrate	13.5-0-45	--	16,800	12,000 (7,500) ⁽⁴⁾	13,290	14,380	13,000	15,100	11,749		10,721	5,947	1.07
PS-33	Best ⁽⁹⁾	K-Power Potassium Nitrate	13.75-0-46	--	8,250	7,100 (27,500) ⁽⁴⁾	7,563	2,600	7,400	7,870	7,201		8,322	4,455	0.83
PS-28	Grow More Corp ⁽²⁾	Grow More	6/30/30	--	2,800	2,500 (<4,000) ⁽⁴⁾	2,599	3,623	2,200	2,490	3,135		2,214	2,101	0.22
PS-25 _s	Best ⁽⁹⁾	Triple Sixteen	16-16-16	--	5,250	4,200 (18,000) ⁽⁴⁾	4,223	3,680	4,000	4,310	3,727		5,173	2,754	0.52
PS-26	Bandini ⁽¹⁾	Sul Po Mag	0-0-22	--	3,550	3,000 (15,000) ⁽⁴⁾	3,073	4,810	3,200	3,160	2,834		4,346	2,180	0.43
PS-27	Plant Marvel	Natriculture	12/31/14	Potassium Nitrate	6,300	5,300	6,680	7,120	5,500	6,450	6,246		6,216	699	0.62
PS-29	Dexol	Stump Remover	Unknown	Unknown	5,800	4,900	5,189	5,290	5,400	5,420	4,576		5,129	330	0.51
PS-32	K Power	Mini Prills	13.75-0-46	Chileans Nitrate	8,200	6,300	6,381	6,300	6,100	6,560	5,862		6,251	241	0.63
PS-06	Peters	All Purpose	20-20-20	Potassium Nitrate	3,400	3,190	3,220	3,680	3,000	3,090	3,128		3,218	239	0.32
Sample of Raw Materials and Control Sample 2/8/99															
PS-34	--	Caliche (Chilean Nitrate Source)	Unknown	Sodium Nitrate	32,800	30,000	26,310	32,980	27,000	30,900	26,120		28,885	2,825	2.89
PS-30	IMC Group	Langbeinite Ore	Unknown	Magnesium, Sulfur, Potassium	15,600	13,000	14,300	20,090	14,000	16,400	13,649		15,240	2,640	1.5
LCS-1 ⁽¹⁰⁾	--	--	Unknown	--	90	--	96	99	100	94	99		98	2	0.009
LCS-2 ⁽¹¹⁾	--	--	Unknown	--	105	--	104	94	99	97	98		98	4	0.009
Blank	--	--	Unknown	--	<50	--	<0.003	<0.003	<0.004	<0.003	--		0.001	0.0002	0.000001

⁽¹⁾ Laboratory extract results (mg/L) were converted to mg/kg units for comparative purposes, by multiplying the result by 10 to account for the 1:10 dilution used to prepare the extracts.

⁽²⁾ Nitrogen, Phosphorus and Potassium Levels.

⁽³⁾ Repeat of Prior Testing.

⁽⁴⁾ Prior Testing Results.

⁽⁵⁾ Duplicate for PS-02.

⁽⁶⁾ Duplicate for PS-08.

⁽⁷⁾ Duplicate for PS-17.

⁽⁸⁾ Duplicate for PS-15.

⁽⁹⁾ Laboratory Control Standard of 100 ppb Quality Control Samples.⁽¹⁰⁾⁽¹¹⁾

⁽¹⁰⁾ Interim duplicate sample analysis.

⁽¹¹⁾ Due to interferences, no value was reported.

⁽¹²⁾ Mean values calculated from results obtained by Del Mar Analytical, Labs 1 through 4 as noted, and the United States Air Force.
For samples with duplicate analyses, the duplicate results were averaged before calculating the overall mean and standard deviation.

⁽¹³⁾ Standard deviation values calculated from results obtained by Del Mar Analytical, Labs 1 through 4 as noted, and the United States Air Force.
For samples with duplicate analyses, the duplicate results were averaged before calculating the overall mean and standard deviation.

⁽¹⁴⁾ Perchlorate sample analyses results from the United States Environmental Protection Agency will be provided after completion of Quality Assurance/Quality Control (QA/QC) evaluation by the EPA.

TABLE 2
SUMMARY OF ION-CHROMATOGRAPHY METHODS

LABORATORIES	SIGNIFICANT DIFFERENCES BETWEEN OUTSIDE LABORATORY PROCEDURES AND DHS PERCHLORATE METHOD
Del Mar Analytical	<ul style="list-style-type: none"> • Used 4 mm Standard Bore Column (AS-11)
American Pacific Corporation (Lab 1)	<ul style="list-style-type: none"> • Used 4 mm Standard Bore Column (AS-16)
United Technologies Corporation (Lab 2)	<ul style="list-style-type: none"> • Used 4 mm Standard Bore Column (AS-11) • Used 100 mM NAOH without Ion-Suppressor
Montgomery Watson Laboratories (Lab 3)	<ul style="list-style-type: none"> • Used 4 mm Standard Bore Column (AS-11)
Thiokol Corporation (Lab 4)	<ul style="list-style-type: none"> • Used 4 mm Standard Bore Column (AS-11) • Used 100 mM NAOH with Ion-Suppressor AS-RS-ULTRA
U.S. Air Force Research Laboratory	<ul style="list-style-type: none"> • Used 4 mm Standard Bore Column (AS-16)
U.S. EPA	<ul style="list-style-type: none"> • To be provided after completion of Quality Assurance/Quality Control Evaluation

98-346/Sa&AnPeFe (Rev. 3) (7/6/99/ey)

APPENDIX A

LABORATORY REPORTS

- A.1 DEL MAR ANALYTICAL
- A.2 AMERICAN PACIFIC CORPORATION
- A.3 UNITED TECHNOLOGIES CORPORATION
- A.4 MONTGOMERY WATSON LABORATORIES
- A.5 THIOKOL CORPORATION
- A.6 UNITED STATES AIR FORCE ARMSTRONG LABORATORY
- A.7 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY⁽³⁾
- A.8 CHEMICAL TESTING SERVICE (PERCHLORATE TITRATION RESULTS)

(3) Perchlorate sample analyses results from the United States Environmental Protection Agency will be provided after completion of Quality Assurance/Quality Control (QA/QC) evaluation.

APPENDIX A.1
DEL MAR ANALYTICAL

LABORATORY REPORT

Prepared For: TRC Environmental Solutions
21 Technology Drive
Irvine, CA 92618

Attention: Richard Scott
Project: 98-346
Lockheed

Sampled: 2/24/99
Received: 2/25/99
Reported: 3/9/99

This laboratory report is confidential and is intended for the sole use of Del Mar Analytical and its client. This entire report was reviewed and approved for release.

CA ELAP Certificate #1197
AZ DHS Licence #AZ0428

DEL MAR ANALYTICAL



Fred Haley
Project Manager



Del Mar Analytical

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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

TRC Environmental Solutions Client Project ID: 98-346
21 Technology Drive Lockheed
Irvine, CA 92618 Sample Descript: Solid
Attention: Richard Scott First Sample #: IB03512

Sampled: Feb 24, 1999
Received: Feb 25, 1999
Extracted: Mar 6-8, 1999
Analyzed: Mar 6-8, 1999
Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Laboratory Number	Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)	QC Batch
IB03512	PS-01	400	4,700	IC06D31S
IB03513	PS-02	200	3,200	IC06D31S
IB03514	PS-03	200	8,600	IC06D31S
IB03515	PS-04	200	7,400	IC06D31S
IB03516	PS-05	200	6,300	IC06D31S
IB03517	PS-06	200	3,100	IC06D31S
IB03518	PS-07	200	4,800	IC06D31S
IB03519	PS-08	200	940	IC06D31S
IB03520	PS-09	200	3,900	IC06D31S
IB03521	PS-10	0.40	N.D.	IC08D31S

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)
Fred Haley
Project Manager

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TRC Environmental Solutions Client Project ID: 98-346
21 Technology Drive Lockheed
Irvine, CA 92618
Attention: Richard Scott Sample Descript: Solid
First Sample #: IB03522

Sampled: Feb 24, 1999
Received: Feb 25, 1999
Extracted: Mar 3-8, 1999
Analyzed: Mar 3-8, 1999
Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Laboratory Number	Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)	QC Batch
IB03522	PS-11	200	7,400	IC06D31S
IB03523	PS-12	200	540	IC06D31S
IB03524	PS-13	1.0	13	IC07D31S
IB03525	PS-14	200	8,100	IC06D31S
IB03526	PS-15	200	5,300	IC06D31S
IB03527	PS-16	200	7,300	IC03D21S
IB03528	PS-17	0.40	N.D.	IC08D31S
IB03529	PS-18	400	600	IC03D21S
IB03530	PS-19	200	2,500	IC03D21S
IB03531	PS-20	200	5,400	IC03D21S

Analytes reported as N.D. were not present at or above the reporting limit.

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TRC Environmental Solutions Client Project ID: 98-346
21 Technology Drive Lockheed
Irvine, CA 92618 Sample Descript: Solid
Attention: Richard Scott First Sample #: IB03532

Sampled: Feb 24, 1999
Received: Feb 25, 1999
Extracted: Mar 3-6, 1999
Analyzed: Mar 3-6, 1999
Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Laboratory Number	Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)	QC Batch
IB03532	PS-21	200	2,400	IC03D21S
IB03533	PS-22	200	1,300	IC03D21S
IB03534	PS-23	200	360	IC03D21S
IB03535	PS-24	200	2,400	IC03D21S
IB03536	PS-25	200	4,200	IC03D21S
IB03537	PS-26	200	3,000	IC03D21S
IB03538	PS-27	400	5,300	IC06D31S
IB03539	PS-28	200	2,500	IC03D21S
IB03551	PS-29	200	4,900	IC03D21S
IB03552	PS-30	400	13,000	IC06D31S

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)
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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

TRC Environmental Solutions Client Project ID: 98-346
21 Technology Drive Lockheed
Irvine, CA 92618 Sample Descript: Solid
Attention: Richard Scott First Sample #: IB03553

Sampled: Feb 24, 1999
Received: Feb 25, 1999
Extracted: Mar 3-6, 1999
Analyzed: Mar 3-6, 1999
Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Laboratory Number	Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)	QC Batch
IB03553	PS-31	400	12,000	IC06D31S
IB03554	PS-32	200	6,300	IC03D21S
IB03555	PS-33	200	7,100	IC03D21S

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)
Fred Haley
Project Manager

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IB03512.TRC <5 of 6>



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9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (619) 505-9596 FAX (619) 505-9689
9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

TRC Environmental Solutions
21 Technology Drive
Irvine, CA 92618
Attention: Richard Scott

Method Blank

Extracted: Mar 3-8, 1999
Analyzed: Mar 3-8, 1999
Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)	QC Batch
Method Blank	0.040	N.D.	IC03D21S
Method Blank	0.040	N.D.	IC06D31S
Method Blank	0.040	N.D.	IC07D31S
Method Blank	0.040	N.D.	IC08D31S

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP# 1197)
Fred Haley
Project Manager

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IB03512.TRC <6 of 6>



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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

MS/MSD DATA REPORT

EPA METHOD: 300.0 Mod.
Matrix: Soil

Date

Analyzed: 3/3/99

Sample: IB03529

Batch: IC03D21S

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR	Acceptance Limits	
	ppb	ppb	ppb	ppb	%	%	%	%	RPD	MPR
Perchlorate	598000	10000000	10900000	10900000	103%	103%	0.0%	103%	20	75-125

Definition of Terms:

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; $((MS-R1) / SP) \times 100$
PR2..... Percent Recovery of MSD; $((MSD-R1) / SP) \times 100$
RPD..... Relative Percent Difference; $((MS-MSD)/(MS+MSD)/2) \times 100$
Acceptance Limits. Statistically determined on an annual basis.

DEL MAR ANALYTICAL



Del Mar Analytical

2852 Alton Ave., Irvine, CA 92606 (949) 261-1022 FAX (949) 261-1228
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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

MS/MSD DATA REPORT

EPA METHOD: 300.0 Mod.

Matrix: Soil

Date

Analyzed: 3/6/99

Sample: IB03512

Batch: IC06D31S

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR	Acceptance Limits	
	ppb	ppb	ppb	ppb	%	%	%	%	RPD	MPR
Perchlorate	4700000	10000000	15300000	15100000	106%	104%	1.3%	105%	20	75-125

Definition of Terms:

R1..... Result of Sample Analysis

Sp..... Spike Concentration Added to Sample

MS..... Matrix Spike Result

MSD..... Matrix Spike Duplicate Result

PR1..... Percent Recovery of MS; $((MS-R1) / SP) \times 100$

PR2..... Percent Recovery of MSD; $((MSD-R1) / SP) \times 100$

RPD..... Relative Percent Difference; $((MS-MSD)/(MS+MSD)/2) \times 100$

Acceptance Limits. Statistically determined on an annual basis.

DEL MAR ANALYTICAL

MS/MSD DATA REPORT

EPA METHOD: 300.0 Mod.
 Matrix: Soil

Date
 Analyzed: 3/7/99

Sample: IB03521

Batch: IC07D31S

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR	Acceptance Limits	
	ppb	ppb	ppb	ppb	%	%	%	%	RPD	MPR
Perchlorate	0	1000000	963000	944000	96%	94%	2.0%	95%	20	75-125

Definition of Terms:

R1..... Result of Sample Analysis
 Sp..... Spike Concentration Added to Sample
 MS..... Matrix Spike Result
 MSD..... Matrix Spike Duplicate Result
 PR1..... Percent Recovery of MS; $((MS-R1) / SP) \times 100$
 PR2..... Percent Recovery of MSD; $((MSD-R1) / SP) \times 100$
 RPD..... Relative Percent Difference; $((MS-MSD)/(MS+MSD)/2) \times 100$
 Acceptance Limits. Statistically determined on an annual basis.

DEL MAR ANALYTICAL



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MS/MSD DATA REPORT

EPA METHOD: 300.0 Mod.
Matrix: Soil

Date
Analyzed: 3/8/99
Sample: IB03521
Batch: IC08D31S

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR	Acceptance Limits	
	ppb	ppb	ppb	ppb	%	%	%	%	RPD	MPR
Perchlorate	0	100	90.1	90.1	90%	90%	0%	90%	20	75-125

Definition of Terms:

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; $((MS-R1) / SP) \times 100$
PR2..... Percent Recovery of MSD; $((MSD-R1) / SP) \times 100$
RPD..... Relative Percent Difference; $((MS-MSD)/(MS+MSD)/2) \times 100$
Acceptance Limits..... Statistically determined on an annual basis.

DEL MAR ANALYTICAL

Ship To: <u>DelMar Analytical Laboratory</u> Attn: _____ <u>2852 Alton Avenue</u> <u>Irvine, CA 92606</u>		Page <u>1</u> of <u>3</u> Project Name: <u>Lockheed</u> Project No.: _____ Site Location: _____ Date: <u> </u> / <u> </u> / <u> </u>		CHAIN OF CUSTODY RECORD															
<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Perchlorate</div> <div style="border: 1px solid black; width: 80%; height: 80%; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px);"></div> </div>																			
Boring/Well No.	Sample No.	Depth	Date	Time	Sample Type			Comp.	Grab.	Sample Containers				Remarks					
					Water	Solid	Other			Vol.	No.	Type	Pres.						
	PS-01		2/24/95			✓									✓				
	PS-02		"			✓									✓				
	PS-03		"			✓									✓				
	PS-04		"			✓									✓				
	PS-05		"			✓									✓				
	PS-06		"			✓									✓				
	PS-07		"			✓									✓				
	PS-08		"			✓									✓				
	PS-09		"			✓									✓				
	PS-10		"			✓									✓				
	PS-11		"			✓									✓				
	PS-12		"			✓									✓				
	PS-13		"			✓									✓				
	PS-14		"			✓									✓				
	PS-15		"			✓									✓				
Total Number of Samples Shipped: <u>33</u> Shipper's Signature: <u>[Signature]</u>																			
Signature								Company				Date		Time					
Relinquished by: <u>[Signature]</u>								TRC				2/24/95		9:30					
Received by: <u>[Signature]</u>								DEL MAR				2-25-99		9:30					
Relinquished by: <u>[Signature]</u>								DEL MAR				2-25-99		9:55					
Received by: <u>[Signature]</u>								DMAI				2/25/99		9:55					
Relinquished by:																			
Received by:																			
Special Instructions / Shipment / Handling/ Storage Requirements:										<input checked="" type="checkbox"/> TRC 21 Technology Drive Irvine, California 92618 (949) 727-9336									
										<input type="checkbox"/> TRC 2815 Mitchell Drive, Suite 103 Walnut Creek, California 94598 (925) 935-3294									
The material(s) listed are received for analysis and/or treatability evaluation and remain the property of the client and not TRC. At the conclusion of the test work, all remaining material(s) will be returned to the client for eventual disposal at a licensed facility.																			

Ship To: Del Mar Analytical Laboratory
Attn: _____
2852 Alton Avenue
Irvine, CA 92606

Page 2 of 3
Project Name: Lockheed
Project No.: _____
Site Location: _____
Date: _____

CHAIN OF CUSTODY RECORD

Boring/Well No.	Sample No.	Depth	Date	Time	Sample Type			Comp.	Grab.	Sample Containers				Analysis	Remarks
					Water	Solid	Other			Vol.	No.	Type	Pres.		
	PS-16		2/24/99			✓									
	PS-17		"			✓									
	PS-18		"			✓									
	PS-19		"			✓									
	PS-20		"			✓									
	PS-21		"			✓									
	PS-22		"			✓									
	PS-23		"			✓									
	PS-24		"			✓									
	PS-25		"			✓									
	PS-26		"			✓									
	PS-27		"			✓									
	PS-28		"			✓									
	PS-29		"			✓									
	PS-30		"			✓									

Total Number of Samples Shipped: _____

Shipper's Signature: _____
Signature _____
Company _____
Date _____
Time _____

Relinquished by: _____

Received by: Rick Shepherd
Relinquished by: Rick Shepherd
Received by: Jim Ondo
Relinquished by: _____
Received by: _____

2/25/99
DEL MAR
DEL MAR
DMAI

TRC 2.25.99
2.25.99
2.25.99
2/25/99

9:30
9:30
9:55
9:55

Special Instructions / Shipment / Handling/ Storage Requirements:

☒
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☒
TRC
21 Technology Drive
Irvine, California 92618
(949) 727-9336

☐
TRC
2815 Mitchell Drive, Suite 103
Walnut Creek, California 94598
(925) 935-3294

[illegible]



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LABORATORY REPORT

Prepared For: TRC Environmental Solutions
21 Technology Drive
Irvine, CA 92618

Attention: Richard Scott
Project: 98-346
Lockheed

Sampled: 2/18/99
Received: 2/26/99
Reported: 3/9/99

This laboratory report is confidential and is intended for the sole use of Del Mar Analytical and its client. This entire report was reviewed and approved for release.

CA ELAP Certificate #1197
AZ DHS Licence #AZ0428

DEL MAR ANALYTICAL

Fred Haley
Project Manager



Del Mar Analytical

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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

TRC Environmental Solutions	Client Project ID: 98-346	Sampled: Feb 18, 1999
21 Technology Drive	Lockheed	Received: Feb 26, 1999
Irvine, CA 92618	Sample Descript: Solid	Extracted: Mar 9, 1999
Attention: Richard Scott	First Sample #: IB03793	Analyzed: Mar 9, 1999
	QC Batch: IC09D31S	Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Laboratory Number	Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
IB03793	PS-34	4,000	30,000

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)
Fred Haley
Project Manager

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IB03793.TRC <2 of 3>



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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (602) 785-0043 FAX (602) 785-0851

TRC Environmental Solutions
21 Technology Drive
Irvine, CA 92618
Attention: Richard Scott

Method Blank

QC Batch: IC09D31S

Extracted: Mar 9, 1999
Analyzed: Mar 9, 1999
Reported: Mar 9, 1999

PERCHLORATE (EPA 300.0 Mod.)

Sample Description	Reporting Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
Method Blank	0.040	N.D.

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP# 1197)
Fred Haley
Project Manager

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IB03793.TRC <3 of 3>

MS/MSD DATA REPORT

EPA METHOD: 300.0 Mod.
 Matrix: Soil

Date
 Analyzed: 3/9/99
 Sample: IB03793
 Batch: IC09D31S

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR	Acceptance Limits	
	ppb	ppb	ppb	ppb	%	%	%	%	RPD	MPR
Perchlorate	293000000	5000000000	5240000000	5300000000	99%	100%	1.1%	100%	20	75-125

Definition of Terms:

R1..... Result of Sample Analysis
 Sp..... Spike Concentration Added to Sample
 MS..... Matrix Spike Result
 MSD..... Matrix Spike Duplicate Result
 PR1..... Percent Recovery of MS; $((MS-R1) / SP) \times 100$
 PR2..... Percent Recovery of MSD; $((MSD-R1) / SP) \times 100$
 RPD..... Relative Percent Difference; $((MS-MSD)/(MS+MSD)/2) \times 100$
 Acceptance Limits... Statistically determined on an annual basis.

[illegible]

APPENDIX A.2
AMERICAN PACIFIC CORPORATION

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-02/IB03513

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	349,800	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Kent W. Ruhman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-03/IB03514

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	895,800	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Robert Richman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-04/IB03515

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	762,500	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-05/IB03516

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	670,500	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Ken W. Richman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-06/IB03517

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999

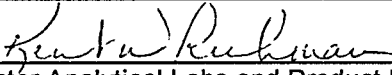
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	322,000	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-07/IB03518

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	473,900	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Kenia R. Ruchman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-08/IB03519

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	109,300	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Kent W. Richman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-09/IB03520

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	438,200	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-10/IB03521

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999

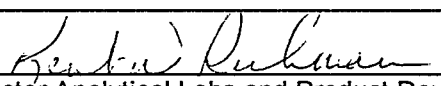
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/22/99	WEC-LAB-060-WI-54	60	ppb	< 60	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-11/IB03522

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	816,600	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Kent W. Richman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-12/IB03523

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	63,640	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Brent W. Reulman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-13/IB03524

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

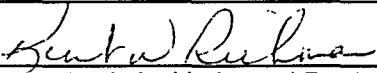
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/22/99	WEC-LAB-060-WI-54	600	ppb	< 600	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-14/IB03525

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	948,300	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-15/IB03526

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999

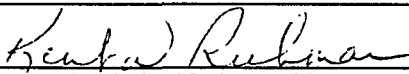
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	606,500	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-16/IB03527

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	751,600	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

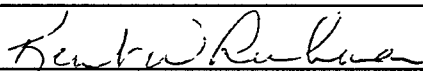
Laboratory: _____
(if not AMPAC) _____
_____Project No.: 98-346 LockheedReport Date: March 22, 1999Client: TRC
21 Technology Drive
Irvine, CA 92618Sample ID: PS-17/IB03528Receipt Date: March 12, 1999Collection Date: February 24, 1999Collection Time: NAPreservation: RefrigerationPreparation Date: March 16, 1999**Test Results**

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/22/99	WEC-LAB-060-WI-54	600	ppb	< 600	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-18/IB03529

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	73,300	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Kent W. Richman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-19/IB03530

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	265,400	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-20/IB03531

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	538,600	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Gentle R. Ruchman
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-21/IB03532

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

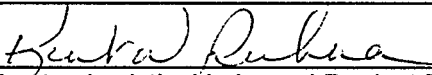
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	296,000	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-22/IB03533

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	154,900	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-23/IB03534

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

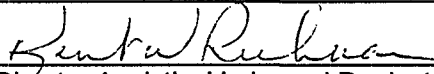
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	46,460	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-24/IB03535

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	259,200	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-25/IB03536

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	422,300	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-26/IB03537

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	307,300	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-27/IB03538

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	668,200	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-28/IB03539

Receipt Date: March 12, 1999

Collection Date:

February 24, 1999

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/17/99	WEC-LAB-060-WI-54	500	ppb	259,900	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-29/IB03551

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

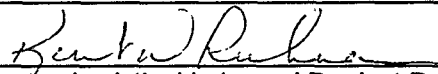
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	518,900	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-30/IB03552

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

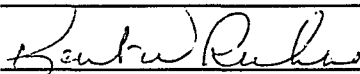
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	1,430,000	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-31/IB03553

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	1,329,000	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-32/IB03554

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	638,100	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:

Robert R. Richey
Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-33/IB03555

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	2500	ppb	756,300	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory: _____
(if not AMPAC) _____

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client: TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-34/IB03793

Receipt Date: March 12, 1999

Collection Date: February 18, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999


Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	5000	ppb	2,631,000	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: LCS1

Receipt Date: March 12, 1999

Collection Date:

NA

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999

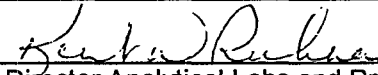
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/22/99	WEC-LAB-060-WI-54	3	ppb	96	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: LCS2

Receipt Date: March 12, 1999

Collection Date:

NA

Collection Time: NA

Preservation:

Refrigeration

Preparation Date: March 16, 1999

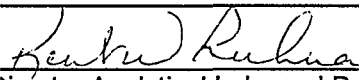
Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/22/99	WEC-LAB-060-WI-54	3	ppb	104	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:


Director Analytical Labs and Product Development



2852 Alton Ave., Irvine, CA 92606 (949) 261-1022 FAX (949) 261-1228
 1814 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (909) 370-1048
 16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843
 2465 W 12th St., Suite 1, Tempe, AZ 85281 (602) 968-8272 FAX (602) 968-1338
 9484 Chesapeake Dr., Suite 806, San Diego, CA 92123 (619) 505-9598 FAX (619) 506-9689

To: American Pacific Corporation

471.1


CHAIN OF CUSTODY FORM Attn: Larry Comings Page 1 of 3


Client Name/Address: TRC 21 Technology Drive Irvine, CA 92618			Project/PO Number: 98-346 Lockheed			Analysis Required													
Project Manager: Richard Scott			Phone Number: (949) 727-9336			Perchlorate													H/Tup: 3/24
Sampler:			Fax Number:																
Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date/Time	Preservatives														Special Instructions
PS-01 / IB03512	Soil*	Glass	1	2/24/99		X													* extract
PS-02 / IB03513																			
PS-03 / IB03514																			
PS-04 / IB03515																			
PS-05 / IB03516																			
PS-06 / IB03517																			
PS-07 / IB03518																			
PS-08 / IB03519																			
PS-09 / IB03520																			
PS-10 / IB03521																			
PS-11 / IB03522																			
PS-12 / IB03523																			
PS-13 / IB03524																			
PS-14 / IB03525																			
Relinquished By:		Date / Time: 3/11/99		Received by: Fed-Ex		Date / Time: 3/11		Turnaround Time: (Check)											
Relinquished By:		Date / Time:		Received by:		Date / Time: 3/12/99 1600		same day _____ 72 hours _____											
Relinquished By:		Date / Time:		Received in Lab by:		Date / Time: 3/12/99 1600		24 hours _____ 5 days _____											
								48 hours _____ normal _____											
								Sample Integrity: (Check)											
								intact _____ on ice _____											

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

CHAIN OF CUSTODY FORM

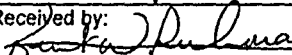
Client Name/Address:			Project/PO Number:			Analysis Required									
Project Manager:			Phone Number:			Special Instructions									
Sampler:			Fax Number:												
Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date/Time	Preservatives										
PS-15 / IB03526	Soil	* Glass	1	2/24/99											
PS-16 / IB03527															
PS-17 / IB03528															
PS-18 / IB03529															
PS-19 / IB03530															
PS-20 / IB03531															
PS-21 / IB03532															
PS-22 / IB03533															
PS-23 / IB03534															
PS-24 / IB03535															
PS-25 / IB03536															
PS-26 / IB03537															
PS-27 / IB03538															
PS-28 / IB03539															

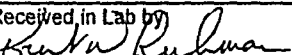
Relinquished By:  Date /Time: 3/11/99

Relinquished By:  Date /Time:

Relinquished By: _____ Date /Time: _____

Received by: Ted-EX Date /Time: 3/11

Received by:  Date /Time: 3/12/99 1600 OK

Received in Lab by:  Date /Time: 3/12/99 1600

Turnaround Time: (Check)

same day _____ 72 hours _____

24 hours _____ 5 days _____

48 hours _____ normal _____

Sample Integrity: (Check)

intact _____ on ice _____

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

Space Propulsion Operations

P.O. Box 49028
San Jose, CA 95161-9028
408-779-9121



Pratt & Whitney

A United Technologies Company

Mr. G. Nicoll
United Technologies Corporation
P.O. Box 49028
San Jose, CA 95161-9028

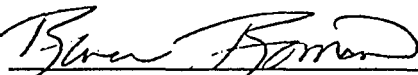
The following samples were received by the Chemical Systems Division Environmental Quality Laboratory (EQL) for analysis under California Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP) certificate number 1639:

COC: DMA14711
DATE SAMPLED: 02/24/99
PROJECT NO.: ESAR000796

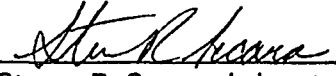
LAB SAMPLE ID	ANALYSIS	LAB SAMPLE ID	ANALYSIS
BLANK	CLO4 (IC)	IB03530	CLO4 (IC)
IB03512	CLO4 (IC)	IB03531	CLO4 (IC)
IB03513	CLO4 (IC)	IB03532	CLO4 (IC)
IB03514	CLO4 (IC)	IB03533	CLO4 (IC)
IB03515	CLO4 (IC)	IB03534	CLO4 (IC)
IB03516	CLO4 (IC)	IB03535	CLO4 (IC)
IB03517	CLO4 (IC)	IB03536	CLO4 (IC)
IB03518	CLO4 (IC)	IB03537	CLO4 (IC)
IB03519	CLO4 (IC)	IB03538	CLO4 (IC)
IB03520	CLO4 (IC)	IB03539	CLO4 (IC)
IB03521	CLO4 (IC)	IB03551	CLO4 (IC)
IB03522	CLO4 (IC)	IB03552	CLO4 (IC)
IB03523	CLO4 (IC)	IB03553	CLO4 (IC)
IB03524	CLO4 (IC)	IB03554	CLO4 (IC)
IB03525	CLO4 (IC)	IB03555	CLO4 (IC)
IB03526	CLO4 (IC)	IB03793	CLO4 (IC)
IB03527	CLO4 (IC)	IB05CLO4C	CLO4 (IC)
IB03528	CLO4 (IC)	IC06CLO4C	CLO4 (IC)
IB03529	CLO4 (IC)		

This report has been reviewed for technical correctness and completeness as verified by the signatures below. An attached QA/QC Report has a discussion of any analytical problems associated with these samples.

Any questions regarding this report should be directed to the Laboratory Director.


Bruce Boman, Chemist
Environmental Quality Laboratory

03/26/99
Date


Steven R. Secara, Laboratory Director
Environmental Quality Laboratory

3/26/99
Date

APPENDIX A.3
UNITED TECHNOLOGIES CORPORATION

TRC

American Pacific Corporation - Utah Operations

10622 West 6400 North, Cedar City, Utah 84720

Tel: (435) 865-5000 Fax: (435) 865-5029

Laboratory:
(if not AMPAC)

Project No.: 98-346 Lockheed

Report Date: March 22, 1999

Client:

TRC
21 Technology Drive
Irvine, CA 92618

Sample ID: PS-01/IB03512

Receipt Date: March 12, 1999

Collection Date: February 24, 1999

Collection Time: NA

Preservation: Refrigeration

Preparation Date: March 16, 1999

Test Results

Analyte	Date	Method	MDL*	Units	Result	Analyst	Deviations
Perchlorate	3/19/99	WEC-LAB-060-WI-54	1000	ppb	468,900	1350	NA

* MDL = Minimum Detectable Limit

Description of Deviations and/or QC Failures:

Authorized Signature and Title:



Director Analytical Labs and Product Development

**QA/QC REPORT
ENVIRONMENTAL QUALITY LABORATORY
(408) 776-4214**

United Technologies
P. O. Box 49028
San Jose, CA 95161-9028

WOR/C of C : DMA14711
Date Sampled : ESAR000796
Project : 02/24/99

QA/QC SUMMARY

No QA/QC problems were associated with these samples.

All samples were analyzed within holding times.

**UNITED TECHNOLOGIES/CHEMICAL SYSTEMS DIVISION
ENVIRONMENTAL QUALITY LABORATORY
REPORT DESCRIPTION**

All Official Analytical Reports (OARs) report amounts as gross values, i.e., not corrected for blank or surrogate recovery. Concentration values of tentatively identified compounds (TICs) reported as a result of the Library Search Compound Report (8260 analysis only) are approximate values only.

SAMPLE TYPE

OARs may contain a comment regarding the type of sample analyzed for that report. A list of these abbreviations follows.

- S: Sample
- R: Replicate of Sample
- M: Matrix spike of listed sample
- B: System blank
- C: Continuing calibration standard
- L: Laboratory control standard
- E: External reference standard
- V: GC/MS verification analysis of Bromofluorobenzene (BFB)

QUALIFIERS

OARs may contain abbreviations referring to compound concentrations or various qualifying statements concerning the compound concentrations reported. A list of these abbreviations follows.

- N/D or <: Compound was not detected at or above the listed reporting limit or concentration.
- U: Compound was not detected at or above listed reporting limit or concentration.
- B: Compound was found in associated system, trip, equipment, or field blank.
- E: Estimated. Reported concentration is outside the instrument's calibration range.
- J: Compound was detected below the listed reporting limit. Concentration should be treated as an estimated value. Tentatively Identified Compounds (TICs) will always have a "J" qualifier since they are not included in the instrument calibration.
- N: Indicates presumptive evidence of a compound. This flag is used only for TICs.

Absence of a qualifier indicates that the compound was detected at or above the listed reporting limit.

SURROGATE RECOVERY SUMMARY AND MATRIX SPIKE RECOVERY FORMS

These pages contain Quality Assurance data. All values outside of established control limits will be flagged with an "*". The total number of matrix spikes or relative percent differences outside of the limits will be listed at the bottom of the matrix spike recovery form.

PERCHLORATE ANALYSIS DATA SHEET
CSD WI 60.12.5W216.2 (EPA METHOD 300.0 modified)
ENVIRONMENTAL QUALITY LABORATORY
(408) 776-4214
DHS-ELAP CERTIFICATE #1639

PROJECT ID:ESAR000796

C of C #: DMA14711

DATE REPORT:03/25/99

MATRIX: WATER

Sample ID	Dilution factor	Detection limit	Reported concentration	Reporting units	Qualifier	Date Sampled	Date Analyzed	Time Analyzed
IB03512	50	200	515	mg/L			03/22/99	13:26
IB03513	50	200	236	mg/L			03/22/99	13:41
IB03514	50	200	773	mg/L			03/22/99	13:56
IB03515	50	200	630	mg/L			03/22/99	14:11
IB03515R	50	200	1184	mg/L			03/22/99	15:57
IB03516	50	200	476	mg/L			03/22/99	14:26
IB03517	1	4	368	mg/L			03/23/99	15:04
IB03518	50	200	883	mg/L			03/22/99	14:56
IB03519	1	4	96.8	mg/L			03/23/99	15:19
IB03520	50	200	512	mg/L			03/22/99	15:27
IB03521	1	4	<4	mg/L	U		03/23/99	15:35
IB03522	50	200	626	mg/L			03/22/99	16:42
IB03523	1	4	59.7	mg/L			03/23/99	15:50
IB03524	1	4	<4	mg/L	U		03/23/99	16:05
IB03525	50	200	864	mg/L			03/22/99	17:27
IB03526	50	200	519	mg/L			03/22/99	17:42
IB03527	50	200	564	mg/L			03/22/99	17:58
IB03528	1	4	<4	mg/L	U		03/23/99	16:20
IB03529	1	4	83.2	mg/L			03/24/99	10:56
IB03529R	1	4	99.3	mg/L			03/24/99	11:12
IB03530	50	200	327	mg/L			03/22/99	18:43
IB03531	50	200	1000	mg/L			03/22/99	18:58
IB03532	50	200	256	mg/L			03/22/99	20:44
IB03533	1	4	264.6	mg/L			03/24/99	11:42
IB03534	1	4	73.8	mg/L			03/24/99	11:57
IB03535	10	40	284	mg/L			03/24/99	14:02
IB03536	50	200	368	mg/L			03/22/99	21:44
IB03537	50	200	481	mg/L			03/22/99	21:59
IB03538	10	40	712	mg/L			03/24/99	14:17
IB03539	1	4	362.3	mg/L			03/24/99	12:42
IB03551	50	200	529	mg/L			03/22/99	22:44
IB03552	50	200	2009	mg/L			03/22/99	22:59
IB03553	10	40	1438	mg/L			03/23/99	14:04
IB03554	10	40	630	mg/L			03/23/99	14:19
IB03555	500	2000	2600	mg/L			03/24/99	09:11
IB03793	10	40	3298	mg/L			03/23/99	14:49

Reporting Limit for Perchlorate is 4 mg/L

EQL QUALITY CONTROL DATA

Sample ID	Spike Added (mg/L)	Spike Concentration (mg/L)	Spike Recovery	QC Limits	Date Analyzed	Time Analyzed
300MB990318-1		<4		<4	03/18/99	13:49
300MB990322-1		<4		<4	03/22/99	20:28
300MB990322-1		<4		<4	03/22/99	11:44
300MB990323-1		<4		<4	03/24/99	10:41
300MLCS990318-1	9.95	10.2	103%	90% - 110%	03/18/99	18:36
300MLCS990318-2	9.95	10.6	107%	90% - 110%	03/18/99	22:40
300MLCS990322-1	9.95	9.56	96%	90% - 110%	03/22/99	19:58
300MLCS990322-2	9.95	9.44	95%	90% - 110%	03/24/99	10:11
300MLCS990323-1	48.35	53.2	110%	90% - 110%	03/24/99	12:57
300MLFB990318-1	19.6	19.2	98%	90% - 110%	03/18/99	18:25
300MLFB990318-2	19.6	18.1	92%	90% - 110%	03/18/99	22:29
300MLFB990322-1	19.6	17.7	90%	90% - 110%	03/22/99	19:43
300MLFB990322-2	38.4	38	99%	90% - 110%	03/24/99	09:56
300MLFB990323-1	38.4	34.5	90%	90% - 110%	03/24/99	14:32
300MLPC990318-1	100	109	109%	90% - 110%	03/18/99	16:07
300MLPC990318-2	100	108.6	109%	90% - 110%	03/18/99	18:46
300MLPC990318-3	100	108.3	108%	90% - 110%	03/18/99	21:15
300MLPC990322-1	100	98	98%	90% - 110%	03/22/99	11:29
300MLPC990322-2	100	102	102%	90% - 110%	03/22/99	16:27
300MLPC990322-3	100	105.2	105%	90% - 110%	03/22/99	20:13
300MLPC990322-4	100	103.4	103%	90% - 110%	03/23/99	13:49
300MLPC990322-5	100	99.4	99%	90% - 110%	03/24/99	08:56
300MLPC990323-1	100	103.9	104%	90% - 110%	03/24/99	10:26

ACCOMPANYING QC SAMPLE DATA

Sample ID	Spike Amount (ug/l)	Reported concentration (ug/l)	% recovery	QC Limits	Date Analyzed	TIME
BLANK	0	0			03/15/99	16:37
IB05CLO4C	100	98.7	99%	90% - 110%	03/15/99	16:49
IB06CLO4C	100	94.3	94%	90% - 110%	03/15/99	17:02

MATRIX SPIKE DATA

Sample ID	Spike Added (ug/L)	Sample Concen. (ug/L)	Matrix Spike Concentration (ug/L)	Matrix Spike Recovery	QC Limits	Date Analyzed	Time Analyzed
IB03515MS	19600	630	18500	91%	75%-125%	03/22/99	16:12
IB03515MS	19600	630	19090	94%	75%-125%	03/18/99	15:56
IB03524MS	19600	0	17890	91%	75%-125%	03/22/99	19:28
IB03524MS	19600	0	18950	97%	75%-125%	03/18/99	18:14
IB03535MS	19600	284	19973	100%	75%-125%	03/22/99	23:30
IB03535MS	19600	284	18490	93%	75%-125%	03/18/99	21:04
IB03555MS	19200	2600	18320	82%	75%-125%	03/24/99	09:41
IB03555MS	19600	0	18940	97%	75%-125%	03/18/99	22:18

300MLPC....: Laboratory Performance Check sample performed to verify that the calibration curve is still valid.

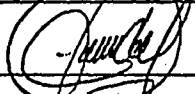
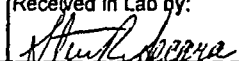
300MLFB....: Laboratory Fortified Blank sample performed to verify recovery of analyte as it is taken through the system.

300MLCS....: Laboratory Control Sample performed to verify system operation. Sample is prepared using a stock standard other than the standard used to prepare the calibration curve.

...MS or ... MSD: Analytical samples spiked with analyte to determine matrix effect on analysis.

Client Name/Address: TRC 21 Technology Drive Irvine, CA 92618		Project/PO Number: 98-346 Lockheed		Analysis Required									
Project Manager: Richard Scott		Phone Number: (949) 727-9336		<div style="float: right; font-size: 2em;">H/TUP: 3/24</div>									
Sampler:		Fax Number:											


Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date/Time	Preservatives	Analysis Required										Special Instructions
PS-01 / IB03512	Soil*	Glass	1	2/24/99		X										* extract
PS-02 / IB03513																
PS-03 / IB03514																
PS-04 / IB03515																
PS-05 / IB03516																
PS-06 / IB03517																
PS-07 / IB03518																
PS-08 / IB03519																
PS-09 / IB03520																
PS-10 / IB03521																
PS-11 / IB03522																
PS-12 / IB03523																
PS-13 / IB03524																
PS-14 / IB03525																

Relinquished By: 	Date /Time: 3/11/99	Received by: Fed - EX	Date /Time: 3/11	Turnaround Time: (Check) same day _____ 72 hours _____ 24 hours _____ 5 days _____ 48 hours _____ normal _____
Relinquished By:	Date /Time:	Received by:	Date /Time:	
Relinquished By:	Date /Time:	Received in Lab by: 	Date /Time: 3/15/99 08:30	

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

CHAIN OF CUSTODY FORM

14713
 Page 2 of 3

Client Name/Address: TRC 21 Technology Drive Irvine, CA 92618			Project/PO Number: 98-346 Lockeed			Analysis Required													
Project Manager: Richard Scott			Phone Number: (949) 727-4336			Perchlorate													
Sampler:			Fax Number:																
Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date/Time	Preservatives														Special Instructions
PS-15 / IB03526	Soil	* Glass	1	2/24/99		X													* extract
PS-16 / IB03527																			
PS-17 / IB03528																			
PS-18 / IB03529																			
PS-19 / IB03530																			
PS-20 / IB03531																			
PS-21 / IB03532																			
PS-22 / IB03533																			
PS-23 / IB03534																			
PS-24 / IB03535																			
PS-25 / IB03536																			
PS-26 / IB03537																			
PS-27 / IB03538																			
PS-28 / IB03539																			
Relinquished By: 		Date /Time: 3/11/99		Received by: Fed - EX		Date /Time: 3/11		Turnaround Time: (Check) same day _____ 72 hours _____ 24 hours _____ 5 days _____ 48 hours _____ normal _____											
Relinquished By:		Date /Time:		Received by:		Date /Time:													
Relinquished By:		Date /Time:		Received in Lab by:		Date /Time:		Sample Integrity: (Check) intact _____ on ice _____											

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

To:

763

CHAIN OF CUSTODY FORM

Page 3 of 3

[illegible]

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30-days from the date of invoice. Sample(s) will be disposed of after 30 days.

APPENDIX A.4
MONTGOMERY WATSON LABORATORIES



MONTGOMERY WATSON LABORATORIES

a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

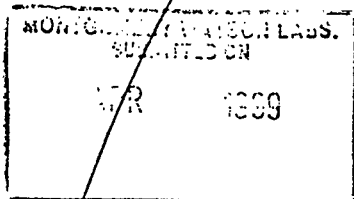
Laboratory Report

for

AWWARF Perchlorate Project
MW/PAS 2

Pasadena , CA 91101

Attention: Andy Eaton
Fax: 626-568-6324



ADE Andy Eaton

Report#: 52565
CLO4

**MONTGOMERY WATSON LABORATORIES**

a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#52565

AWWARF Perchlorate Project
Andy Eaton
MW/PAS 2
Pasadena, CA 91101

Samples Received
12-mar-1999 13:37:03

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
PS-01/IB03512	EXTRACT (990312323)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		530000	ug/l	40000	10000
PS-02/IB03513	EXTRACT (990312324)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		310000	ug/l	16000	4000
PS-03/IB03514	EXTRACT (990312325)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		940000	ug/l	40000	10000
PS-04/IB03515	EXTRACT (990312326)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		800000	ug/l	40000	10000
PS-05/IB03516	EXTRACT (990312327)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		620000	ug/l	40000	10000
PS-06/IB03517	EXTRACT (990312328)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		300000	ug/l	40000	10000
PS-07/IB03518	EXTRACT (990312329)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		500000	ug/l	40000	10000
PS-08/IB03519	EXTRACT (990312330)			Sampled on 02/24/99				
04/02/99	94668	(MOD/EPA 300)	Perchlorate		97000	ug/l	4800	1200
PS-09/IB03520	EXTRACT (990312331)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		430000	ug/l	40000	10000

**MONTGOMERY WATSON LABORATORIES**

a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#52565

AWWARF Perchlorate Project
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
PS-10/IB03521	EXTRACT	(990312332)	Sampled on	02/24/99				
04/07/99	94669	(MOD/EPA 300)	Perchlorate	ND	ug/l	40	10	
PS-11/IB03522	EXTRACT	(990312333)	Sampled on	02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate	880000	ug/l	40000	10000	
PS-12/IB03523	EXTRACT	(990312334)	Sampled on	02/24/99				
03/18/99	93707	(MOD/EPA 300)	Perchlorate	53000	ug/l	8000	2000	
PS-13/IB03524	EXTRACT	(990312335)	Sampled on	02/24/99				
04/07/99	94669	(MOD/EPA 300)	Perchlorate	(87)	ug/l	20	5	
PS-14/IB03525	EXTRACT	(990312336)	Sampled on	02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate	900000	ug/l	80000	20000	
PS-15/IB03526	EXTRACT	(990312337)	Sampled on	02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate	610000	ug/l	40000	10000	
PS-16/IB03527	EXTRACT	(990312338)	Sampled on	02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate	740000	ug/l	40000	10000	
PS-17/IB03528	EXTRACT	(990312339)	Sampled on	02/24/99				
04/07/99	94669	(MOD/EPA 300)	Perchlorate	220	ug/l	20	5	
PS-18/IB03529	EXTRACT	(990312340)	Sampled on	02/24/99				
03/18/99	93707	(MOD/EPA 300)	Perchlorate	75000	ug/l	8000	2000	
PS-19/IB03530	EXTRACT	(990312341)	Sampled on	02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate	270000	ug/l	80000	20000	

**MONTGOMERY WATSON LABORATORIES**

a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#52565

AWWARF Perchlorate Project
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
PS-20/IB03531	EXTRACT (990312342)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	480000	ug/l	40000	10000	
PS-21/IB03532	EXTRACT (990312343)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	290000	ug/l	40000	10000	
PS-22/IB03533	EXTRACT (990312344)	Sampled on	02/24/99					
03/18/99	93707	(MOD/EPA 300)	Perchlorate	140000	ug/l	8000	2000	
PS-23/IB03534	EXTRACT (990312345)	Sampled on	02/24/99					
03/18/99	93707	(MOD/EPA 300)	Perchlorate	34000	ug/l	8000	2000	
PS-24/IB03535	EXTRACT (990312346)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	220000	ug/l	16000	4000	
PS-25/IB03536	EXTRACT (990312347)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	400000	ug/l	40000	10000	
PS-26/IB03537	EXTRACT (990312348)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	320000	ug/l	40000	10000	
PS-27/IB03538	EXTRACT (990312349)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	550000	ug/l	40000	10000	
PS-28/IB03539	EXTRACT (990312350)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	220000	ug/l	40000	10000	
PS-29/IB03551	EXTRACT (990312351)	Sampled on	02/24/99					
03/18/99	93708	(MOD/EPA 300)	Perchlorate	540000	ug/l	40000	10000	

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Laboratory
Report
#52565

AWWARF Perchlorate Project
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
<hr/>								
PS-30/IB03552	EXTRACT (990312352)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		1400000	ug/l	160000	40000
PS-31/IB03553	EXTRACT (990312353)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		1300000	ug/l	160000	40000
PS-32/IB03554	EXTRACT (990312354)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		610000	ug/l	40000	10000
PS-33/IB03555	EXTRACT (990312355)			Sampled on 02/24/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		740000	ug/l	40000	10000
PS-34/IB03793	EXTRACT (990312356)			Sampled on 02/18/99				
03/18/99	93708	(MOD/EPA 300)	Perchlorate		2700000	ug/l	800000	200000
BLANK (990312357)				Sampled on 02/24/99				
03/18/99	93707	(MOD/EPA 300)	Perchlorate		ND	ug/l	4.0	1
LCS1 100 PPB (990312358)				Sampled on 02/24/99				
03/18/99	93707	(MOD/EPA 300)	Perchlorate		100	ug/l	8.0	2
LCS2 100 PPB (990312359)				Sampled on 02/24/99				
03/18/99	93707	(MOD/EPA 300)	Perchlorate		99	ug/l	8.0	2



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Report
Comments
#52565

(990312332)

CLO4

This sample was pre-treated prior to the analysis.

(990312335)

CLO4

This sample was pre-treated prior to the analysis. The reported result is reported as an estimate due to reclining base line. If diluted or pre-treated more sample would possibly come out with ND with a higher reporting limit.

(990312339)

CLO4

This sample was pretreated prior to the analysis.



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Laboratory
QC Report
#52565

AWWARF Perchlorate Project

QC Batch #93707

Perchlorate

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Perchlorate	20.0	19.5	97.5	(90.00 - 110.00)	
LCS2	Perchlorate	20.0	21.7	108.5	(90.00 - 110.00)	11
MBLK	Perchlorate	ND				

QC Batch #93708

Perchlorate

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Perchlorate	20.0	19	95.0	(90.00 - 110.00)	
LCS2	Perchlorate	20.0	19.6	98.0	(90.00 - 110.00)	3.1
MBLK	Perchlorate	ND				

QC Batch #94668

Perchlorate

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Perchlorate	20.0	19.8	99.0	(90.00 - 110.00)	
LCS2	Perchlorate	20.0	20.1	100.5	(90.00 - 110.00)	1.5
MBLK	Perchlorate	ND				

QC Batch #94669

Perchlorate

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Perchlorate	50.0	46.2	92.4	(90.00 - 110.00)	
LCS2	Perchlorate	100	102	102.0	(90.00 - 110.00)	
MBLK	Perchlorate	ND				

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only and not applicable for ICR monitoring.

APPENDIX A.5
THIOKOL CORPORATION

CERTIFICATE OF ANALYSIS

Listing of sample Information and Testing Requested

Monday, March 29, 1999

TESTED FOR Thiokol: DLV
Environmental Monitoring
M/S 301
Thiokol Corp, UT 84322

Paul Hancock

Project: Misc. Environmental Testing

ANALYZED BY Thiokol Environmental Laboratory
Thiokol Corporation
P.O. Box 707 M/S 245
Brigham City, UT 84302-0707
801-863-3732
800-863-8080

Login Number L2200

Lab No	Client Number	Description	Received	CollectDate/Time
Test Requested				Matrix
L2200-1	PS-01/ IBO3512		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-2	PS-02/ IBO3513		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-3	PS-03/ IBO3514		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-4	PS-04/ IBO3515		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-5	PS-05/ IBO3516		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-6	PS-06/ IBO3517		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-7	PS-07/ IBO3518		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-8	PS-08/ IBO3519		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-9	PS-09/ IBO3520		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-10	PS-10/ IBO3521		03/15/99	02/24/99 00:00
SOP 361		Perchlorate - Ion Chromatography		Water
L2200-11	PS-11/ IBO3522		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-12	PS-12/ IBO3523		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-13	PS-13/ IBO3524		03/15/99	02/24/99 00:00
SOP 361		Perchlorate - Ion Chromatography		Water
L2200-14	PS-14/ IBO3525		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-15	PS-15/ IBO3526		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-16	PS-16/ IBO3527		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-17	PS-17/ IBO3528		03/15/99	02/24/99 00:00
SOP 361		Perchlorate - Ion Chromatography		Water
L2200-18	PS-18/ IBO3529		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-19	PS-19/ IBO3530		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-20	PS-20/ IBO3531		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water
L2200-21	PS-21/ IBO3532		03/15/99	02/24/99 00:00
SOP 302		Perchlorate - Ion Chromatography		Water

L2200-22	PS-22/ IBO3533	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-23	PS-23/ IBO3534	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-24	PS-24/ IBO3535	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-25	PS-25/ IBO3536	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-26	PS-26/ IBO3537	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-27	PS-27/ IBO3538	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-28	PS-28/ IBO3539	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-29	PS-29/ IBO3551	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-30	PS-30/ IBO3552	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-31	PS-31/ IBO3553	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-32	PS-32/ IBO3554	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-33	PS-33/ IBO3555	03/15/99	02/24/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-34	PS-34/ IBO3793	03/15/99	02/18/99 00:00
SOP 302	Perchlorate - Ion Chromatography		Water
L2200-35	BLANK	03/15/99	
SOP 361	Perchlorate - Ion Chromatography		Water
L2200-36	LCS1 100PPB	03/15/99	
SOP 361	Perchlorate - Ion Chromatography		Water
L2200-37	LCS2 100PPB	03/15/99	
SOP 361	Perchlorate - Ion Chromatography		Water

Comments:

PS-10, PS-13, PS-17, PS-35, PS-36, and PS-37: These samples were analyzed using a more sensitive method. Their results are reported in Micrograms/Liter rather than Milligrams/Liter.

PS-10, PS-13, and PS-17: These samples were diluted to remove interfering matrix effects.

PS-36 and PS-37: These samples were diluted to bring their value within the calibration range of the method used.

Certified By *SMA*
James M. Anderson, QC Officer

3/29/99
Date

This certifies that the following samples were analyzed using good laboratory practices to show the following results:

Listing of Results by Sample

Sample ID: PS-01/ IBO3512			Lab ID: L2200-1			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	471	mg/l	15	75	100	SOP 302	CWS	03/19/99 16:01
Sample ID: PS-02/ IBO3513			Lab ID: L2200-2			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	324	mg/l	15	75	100	SOP 302	CWS	03/19/99 16:15
Sample ID: PS-03/ IBO3514			Lab ID: L2200-3			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	886	mg/l	15	75	100	SOP 302	CWS	03/19/99 16:29
Sample ID: PS-04/ IBO3515			Lab ID: L2200-4			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	766	mg/l	15	75	100	SOP 302	CWS	03/19/99 16:43
Sample ID: PS-05/ IBO3516			Lab ID: L2200-5			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	636	mg/l	15	75	100	SOP 302	CWS	03/19/99 16:57
Sample ID: PS-06/ IBO3517			Lab ID: L2200-6			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	309	mg/l	15	75	100	SOP 302	CWS	03/19/99 17:11
Sample ID: PS-07/ IBO3518			Lab ID: L2200-7			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	492	mg/l	15	75	100	SOP 302	CWS	03/19/99 17:25
Sample ID: PS-08/ IBO3519			Lab ID: L2200-8			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	101	mg/l	3	15	20	SOP 302	CWS	03/19/99 18:21
Sample ID: PS-09/ IBO3520			Lab ID: L2200-9			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	438	mg/l	15	75	100	SOP 302	CWS	03/19/99 18:35
Sample ID: PS-10/ IBO3521			Lab ID: L2200-10			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	U	ug/l	300	1000	100	SOP 361	CWS	03/26/99 14:23
Sample ID: PS-11/ IBO3522			Lab ID: L2200-11			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	829	mg/l	15	75	100	SOP 302	CWS	03/19/99 19:03
Sample ID: PS-12/ IBO3523			Lab ID: L2200-12			Collect Date: 02/24/99 00:00		
<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	58	mg/l	3	15	20	SOP 302	CWS	03/19/99 19:17

Sample ID: PS-13/ IBO3524 Lab ID: L2200-13 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	962	ug/l	300	1000	100	SOP 361	CWS	03/26/99 15:05

Sample ID: PS-14/ IBO3525 Lab ID: L2200-14 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	992	mg/l	15	75	100	SOP 302	CWS	03/19/99 19:45

Sample ID: PS-15/ IBO3526 Lab ID: L2200-15 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	608	mg/l	15	75	100	SOP 302	CWS	03/19/99 19:59

Sample ID: PS-16/ IBO3527 Lab ID: L2200-16 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	721	mg/l	15	75	100	SOP 302	CWS	03/19/99 20:13

Sample ID: PS-17/ IBO3528 Lab ID: L2200-17 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	U	ug/l	300	1000	100	SOP 361	CWS	03/26/99 15:46

Sample ID: PS-18/ IBO3529 Lab ID: L2200-18 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	69	mg/l	3	15	20	SOP 302	CWS	03/19/99 21:22

Sample ID: PS-19/ IBO3530 Lab ID: L2200-19 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	266	mg/l	15	75	100	SOP 302	CWS	03/19/99 21:36

Sample ID: PS-20/ IBO3531 Lab ID: L2200-20 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	556	mg/l	15	75	100	SOP 302	CWS	03/19/99 21:50

Sample ID: PS-21/ IBO3532 Lab ID: L2200-21 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	300	mg/l	15	75	100	SOP 302	CWS	03/19/99 22:04

Sample ID: PS-22/ IBO3533 Lab ID: L2200-22 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	153	mg/l	3	15	20	SOP 302	CWS	03/19/99 22:18

Sample ID: PS-23/ IBO3534 Lab ID: L2200-23 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	43	mg/l	3	15	20	SOP 302	CWS	03/19/99 22:32

Sample ID: PS-24/ IBO3535 Lab ID: L2200-24 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	248	mg/l	15	75	100	SOP 302	CWS	03/19/99 22:46

Sample ID: PS-25/ IBO3536 Lab ID: L2200-25 Collect Date: 02/24/99 00:00

<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	431	mg/l	15	75	100	SOP 302	CWS	03/19/99 23:00

Sample ID: PS-26/ IBO3537	Lab ID: L2200-26	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	316	mg/l	15	75	100	SOP 302	CWS	03/19/99 23:14

Sample ID: PS-27/ IBO3538	Lab ID: L2200-27	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	645	mg/l	15	75	100	SOP 302	CWS	03/20/99 12:10

Sample ID: PS-28/ IBO3539	Lab ID: L2200-28	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	249	mg/l	15	75	100	SOP 302	CWS	03/20/99 12:24

Sample ID: PS-29/ IBO3551	Lab ID: L2200-29	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	542	mg/l	15	75	100	SOP 302	CWS	03/20/99 12:38

Sample ID: PS-30/ IBO3552	Lab ID: L2200-30	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	1640	mg/l	15	75	100	SOP 302	CWS	03/20/99 12:52

Sample ID: PS-31/ IBO3553	Lab ID: L2200-31	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	1510	mg/l	15	75	100	SOP 302	CWS	03/20/99 01:06

Sample ID: PS-32/ IBO3554	Lab ID: L2200-32	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	656	mg/l	15	75	100	SOP 302	CWS	03/20/99 02:02

Sample ID: PS-33/ IBO3555	Lab ID: L2200-33	Collect Date: 02/24/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	787	mg/l	15	75	100	SOP 302	CWS	03/20/99 02:16

Sample ID: PS-34/ IBO3793	Lab ID: L2200-34	Collect Date: 02/18/99 00:00
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	3090	mg/l	15	75	100	SOP 302	CWS	03/20/99 02:30

Sample ID: BLANK	Lab ID: L2200-35	Collect Date:
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	U	ug/l	3	10	1	SOP 361	CWS	03/26/99 16:42

Sample ID: LCS1 100PPB	Lab ID: L2200-36	Collect Date:
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	94	ug/l	6	20	2	SOP 361	CWS	03/26/99 16:56

Sample ID: LCS2 100PPB	Lab ID: L2200-37	Collect Date:
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<u>Test Parameter</u>	<u>Result</u>	<u>Units</u>	<u>MDL</u>	<u>EQL</u>	<u>Dil. Factor</u>	<u>Method</u>	<u>Analyst</u>	<u>Test Date</u>
PERCHLORATE	97	ug/l	6	20	2	SOP 361	CWS	03/26/99 17:10

Data Reporting Qualifiers

- U** Indicates compound was analyzed for and was not detected, or the compound was detected but was below the MDL.
- B** Gas Chromatography and Mass Spectral Data Flag. This flag is used when an analyte is found in the blank as well as the sample
- J** Gas Chromatography and Mass Spectral Data Flag. Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds or when the data indicated the presence of a compound that meets the identification criteria but the result is less than the EQL (e.g. 3 J with an EQL of 10)
- MDL** **Method Detection Limit:** The minimum concentration of a substance that can be confidently measured and reported. The laboratory has demonstrated that the MDL can be achieved in a laboratory reagent blank, but does not guarantee it can be achieved in all sample matrices. The MDL is approximately three times the signal noise level.
- EQL** **Estimated Quantitation Limit:** The EQL generally is 5 to 10 times the MDL. For many analytes the EQL is selected as the value of the lowest standard in the calibration curve.
- Dil. Factor** **Dilution Factor:** The prepared sample was diluted by this factor because the sample was too concentrated or due to other interferences in the sample matrix. Any dilution factor causes an appropriate increase in the MDL and EQL.



Del Mar Analytical

2852 Alton Ave., Irvine, CA 92606 (949) 261-1022 FAX (949) 261-1228
 1014 E. Cooley Dr., Suite A, Cotton, CA 92324 (909) 370-4687 FAX (909) 370-1048
 16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 778-1644 FAX (818) 778-1643
 2465 W 12th St., Suite 1, Tempe, AZ 85281 (602) 968-8272 FAX (602) 968-1358
 8484 Cheapsake Dr., Suite 805, San Diego, CA 92123 (619) 505-9596 FAX (619) 505-9689

To: Thiol Propulsion Group

L27 14711

CHAIN OF CUSTODY FORM

Attn: Paul Hancock

Page 1 of 3

Client Name/Address: TRC 21 Technology Drive Irvine, CA 92618			Project/PO Number: 98-346 Lockheed			Analysis Required									
Project Manager: Richard Scott			Phone Number: (949) 727-9336			<div style="display: flex; justify-content: space-between;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Perchlorate</div> <div style="text-align: right;">H/TOP: 3/24</div> </div>									
Sampler:			Fax Number:												
Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date/Time	Preservatives	Special Instructions									
PS-01 / IB03512	Soil*	Glass	1	2/24/99		* extract									
PS-02 / IB03513															
PS-03 / IB03514															
PS-04 / IB03515															
PS-05 / IB03516															
PS-06 / IB03517															
PS-07 / IB03518															
PS-08 / IB03519															
PS-09 / IB03520															
PS-10 / IB03521															
PS-11 / IB03522															
PS-12 / IB03523															
PS-13 / IB03524															
PS-14 / IB03525															
Relinquished By: <i>[Signature]</i>			Date/Time: 3/11/99			Received by: Fed-Ex			Date/Time: 3/11/99			Turnaround Time: (Check)			
Relinquished By: <i>[Signature]</i>			Date/Time:			Received by: <i>[Signature]</i>			Date/Time: 3/12/99			same day _____ 72 hours _____ 24 hours _____ 5 days _____ 48 hours _____ normal _____			
Relinquished By: <i>[Signature]</i> / Paul Hancock			Date/Time: 3/15/99 9:00			Received in Lab by: <i>[Signature]</i>			Date/Time: 3/15/99 0900			Sample Integrity: (Check)			
												intact _____ on ice _____			

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

CHAIN OF CUSTODY FORM

Page 2 of 3

Client Name/Address: TRC 21 Technology Drive Irvine, CA 92618			Project/PO Number: 98-346 Lockeed			Analysis Required															
Project Manager: Richard Scott			Phone Number: (949) 727-4336			Perchlorate															
Sampler:			Fax Number:																		
Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date/Time	Preservatives																Special Instructions
PS-15 / IB03526	Soil	* Glass	1	2/24/99		X															* extract
PS-16 / IB03527																					
PS-17 / IB03528																					
PS-18 / IB03529																					
PS-19 / IB03530																					
PS-20 / IB03531																					
PS-21 / IB03532																					
PS-22 / IB03533																					
PS-23 / IB03534																					
PS-24 / IB03535																					
PS-25 / IB03536																					
PS-26 / IB03537																					
PS-27 / IB03538																					
PS-28 / IB03539																					
Relinquished By: <i>[Signature]</i>			Date / Time: 3/11/99			Received by: Fed-EX			Date / Time: 3/11/99			Turnaround Time: (Check) same day _____ 72 hours 24 hours _____ 5 days _____ 48 hours _____ normal _____									
Relinquished By: <i>[Signature]</i>			Date / Time: 3-15-99 9:00			Received by: <i>[Signature]</i>			Date / Time: 3/12/99 1400 hrs			Sample Integrity: (Check) intact _____ on ice _____									
Relinquished By: <i>[Signature]</i>			Date / Time: 3-15-99 9:00			Received in Lab by: <i>[Signature]</i>			Date / Time: 3/15/99 0900												

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

70:

Thiokol LWR E11712

14753

2220

Page 3 of 3

CHAIN OF CUSTODY FORM

[illegible]

Note: By relinquishing samples to Del Mar Analytical, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

APPENDIX A.6
AIR FORCE RESEARCH LABORATORY

TRC

Perchlorate

Sequence

041499a

Method

eg401.0ml35mmoh-tds-ap

1000 uL

	Conc (ppb)	Area	RT
Std	5.0	10688	17.25
Std	5.0	9151	17.32
Std	5.0	9143	17.32
Std	5.0	9556	17.38
Std	5.0	9935	17.17
Std	5.0	9874	17.17
Std	5.0	9835	17.17
Std	5.0	9635	17.17
Std	10.0	16415	17.40
Std	10.0	16712	17.28
Std	10.0	17609	17.17
Std	25.0	47817	17.32
Std	25.0	46827	17.38
Std	50.0	100957	17.25
Std	100.0	217589	17.20
Std	100.0	208748	17.43
Std	200.0	444062	17.10
Std	500.0	1046409	17.03
Std	500.0	1055535	17.03
Std	500.0	1055124	16.97

MDL Calculations

concentration (ppb)	5
Average	9727
Standard Deviation	462
%CV	5%
Student t-test (df = 7)	2.998
MDL (ppb)	0.71
LRL (ppb)	2.1
URL (ppb)	500

Fertilizer Extracts			Y=		2110.3 X					
Samples	RT	Area	Diluted	Dilution	Adjusted		Duplicate	Adjusted		Adjusted
					For Dilution	25 ppb		For Dilution	For Dilution	
ug/L		Count	Conc.	Factor	mg/L	Spike	% Recovery	LRL/D	URL/D	
LCS1	13.3	208776	98.93	1	0.099			0.002		0.5
LCS2	13.3	206792	97.99	1	0.098			0.002		0.5
ps1, 5000	17.1	201810	95.63	5000	478.2			11		2500
ps2, 2500	17.1	259763	123.09	2500	307.7			5		1250
ps3, 10000	17.2	162037	76.78	10000	767.8			21		5000
ps4, 5000	17.3	291546	138.15	5000	690.8			11		2500
ps5, 5000	17.4	291128	137.96	5000	689.8			11		2500
ps5, 5000, sp25ppb	17.4	339967	161.10	5000	712.9	93%		11		2500
ps6, 5000	17.4	132036	62.57	5000	312.8			11		2500
ps6, 5000, dup	17.5	126539	59.96	5000	299.8		96%	11		2500
ps7, 5000	17.4	184404	87.38	5000	436.9			11		2500
ps8, 5000	17.4	33911	16.07	5000	80.3			11		2500
ps9, 5000	17.4	170872	80.97	5000	404.9			11		2500
ps10, Undiluted	13.2	Interference	Interference	1	Interference			0		1
ps11, 5000	17.5	298312	141.36	5000	706.8			11		2500
ps12, 500	17.5	221964	105.18	500	52.6			1		250
ps13, Undiluted	13.2	Interference	Interference	1	Interference			0		1
ps14, 5000	17.5	291032	137.91	5000	689.6			11		2500
ps15, 5000	17.5	197232	93.46	5000	467.3			11		2500
ps15, 5000, sp25ppb	17.1	251038	118.96	5000	492.8	102%		11		2500
ps16, 5000	17.6	261414	123.88	5000	619.4			11		2500
ps16, 5000, dup	17.1	263542	124.88	5000	624.4		101%	11		2500
ps17, Undiluted	17.6	Interference	Interference	5000	Interference			11		2500
ps18, 500	17.5	381612	180.83	500	90.4			1		250
ps19, 5000	17.4	86661	41.07	5000	205.3			11		2500
ps20, 5000	17.3	299576	141.96	5000	709.8			11		2500
ps21, 5000	17.1	100300	47.53	5000	237.6			11		2500
ps22, 1000	17.1	420941	199.47	1000	199.5			2		500
ps23, 1000	17.1	108413	51.37	1000	51.4			2		500
ps24, 5000	17.1	106784	50.60	5000	253.0			11		2500
ps25, 5000	17.1	157284	74.53	5000	372.7			11		2500
ps25, 5000, sp25ppb	17.0	210290	99.65	5000	397.8	100%		11		2500
ps26, 5000	17.1	119622	56.68	5000	283.4			11		2500
ps26, 5000, dup	17.0	117618	55.74	5000	278.7		98%	11		2500
ps27, 5000	17.1	263617	124.92	5000	624.6			11		2500
ps28, 5000	17.1	132305	62.69	5000	313.5			11		2500
ps29, 5000	17.1	193132	91.52	5000	457.6			11		2500
ps30, 10000	17.1	288029	136.49	10000	1364.9			21		5000
ps31, 10000	17.0	247936	117.49	10000	1174.9			21		5000
ps32, 5000	17.0	247408	117.24	5000	586.2			11		2500
ps33, 5000	17.0	303946	144.03	5000	720.1			11		2500
ps34, 25000	17.0	220549	104.51	25000	2612.8			53		12500

Fertilizers

Calculated based on adding 1 g of fertilizer sample to 10 mL of water

Samples	Concentration	Extract Volume (L)	Amount C1O4- (mg)	Amount Fertilizer (kg)	Conc. (g/kg) (ppt)	Wt/Wt%
	mg/L (ppm) ug/L					
ps1, 5000	478.2	0.01	4.782	0.001	4.78	0.48%
ps2, 2500	307.7	0.01	3.077	0.001	3.08	0.31%
ps3, 10000	767.8	0.01	7.678	0.001	7.68	0.77%
ps4, 5000	690.8	0.01	6.908	0.001	6.91	0.69%
ps5, 5000	689.8	0.01	6.898	0.001	6.90	0.69%
ps6, 5000	312.8	0.01	3.128	0.001	3.13	0.31%
ps7, 5000	436.9	0.01	4.369	0.001	4.37	0.44%
ps8, 5000	80.3	0.01	0.803	0.001	0.80	0.08%
ps9, 5000	404.9	0.01	4.049	0.001	4.05	0.40%
ps10, Undiluted	ND	0.01	Interference	0.001	Interference	Interference
ps11, 5000	706.8	0.01	7.068	0.001	7.07	0.71%
ps12, 500	52.6	0.01	0.526	0.001	0.53	0.05%
ps13, Undiluted	ND	0.01	Interference	0.001	Interference	Interference
ps14, 5000	689.6	0.01	6.896	0.001	6.90	0.69%
ps15, 5000	467.3	0.01	4.673	0.001	4.67	0.47%
ps16, 5000	619.4	0.01	6.194	0.001	6.19	0.62%
ps17, Undiluted	ND	0.01	Interference	0.001	Interference	Interference
ps18, 500	90.4	0.01	0.904	0.001	0.90	0.09%
ps19, 5000	205.3	0.01	2.053	0.001	2.05	0.21%
ps20, 5000	709.8	0.01	7.098	0.001	7.10	0.71%
ps21, 5000	237.6	0.01	2.376	0.001	2.38	0.24%
ps22, 1000	199.5	0.01	1.995	0.001	1.99	0.20%
ps23, 1000	51.4	0.01	0.514	0.001	0.51	0.05%
ps24, 5000	253.0	0.01	2.530	0.001	2.53	0.25%
ps25, 5000	372.7	0.01	3.727	0.001	3.73	0.37%
ps26, 5000	283.4	0.01	2.834	0.001	2.83	0.28%
ps27, 5000	624.6	0.01	6.246	0.001	6.25	0.62%
ps28, 5000	313.5	0.01	3.135	0.001	3.13	0.31%
ps29, 5000	457.6	0.01	4.576	0.001	4.58	0.46%
ps30, 10000	1364.9	0.01	13.649	0.001	13.65	1.36%
ps31, 10000	1174.9	0.01	11.749	0.001	11.75	1.17%
ps32, 5000	586.2	0.01	5.862	0.001	5.86	0.59%
ps33, 5000	720.1	0.01	7.201	0.001	7.20	0.72%
ps34, 25000	2612.8	0.01	26.128	0.001	26.13	2.61%

APPENDIX A.7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
(TO BE PROVIDED)

TRC

APPENDIX A.8
CHEMICAL TESTING SERVICE (PERCHLORATE TITRATION RESULTS)

CTS
CHEMICAL TESTING SERVICE
23441 GOLDEN SPRINGS
DIAMOND BAR, CA 91765
909-860-4100

Richard Scott
TRC Environmental Solutions Inc
21 Technology Drive
Irvine, CA 92618

April 18, 1999

LABORATORY REPORT
PERCHLORATE TITRATION RESULTS

Please find attached Tables 1 which summarizes the the results of the Triphenylstilbonium tritration for the perchlorate ion. Table 2 provides a summary of the ion-selective electrode analyses of the fertilizer samples conducted during the sample extraction process. A summary of the methods of analysis used in the studies is provided below. These methods are not state approved laboratory methods, and have been conducted to provide additional information on potential perchlorate interferences during Ion-Chromatography, and as a confirmatory analysis of Ion-chromatography results

EXTRACTION METHODOLOGY

A 10 gram sample of the extract was diluted into 50 ml of distilled water and adsorbed onto 25 grams of Dowex 1 resin (Boyd, 1968). The column was eluted with 100 ml of potassium bicarbonate solution (0.01 M) to remove nitrates, chloride, chlorite and chlorate ions. The wash solutions were monitored using a perchlorate selective electrode (Orion, Model 938101), to determine if a portion of the perchlorate eluted in the rinse. The extraction column was then rinsed with 75 mls of sodium fluoroborate solution (0.05 M) and the rinsed collected. The column was then rinsed with an additional 25 ml of sodium fluoroborate solution which was added to the previous eluate. The sodium fluoroborate solution was then analyzed using the perchlorate selective electrode. To determine the efficiency of the extraction process, various control samples and duplicate samples were also extracted and analyzed.

ANALYTICAL METHODOLOGY

The extracts produced above were analyzed using the Triphenylstilbonium titration method (Morris, 1965). A 10 ml aliquot of the extract was titrated with 0.01 M Triphenylstilbonium solution using bromocresol green as an indicator, in conjunction with the perchlorate selective electrode. The endpoint of the titration was clearly visible, with the bromocresol green color disappearing, producing a clear solution. At this endpoint, the perchlorate selective ion indicated no detectable perchlorate concentration.

REFERENCES

Boyd, G.E., Larson, Q.V., Journal American Chemical Society, (90), 5092, 1968.

Morris, M.D., Analytical Chemistry, (37), 977, 1965.

Note: The attached results should be considered as estimated quantities only, since this method has not been evaluated or approved by the California Department of Health Services.

TABLE 1
PERCHLORATE TITRATION RESULTS

<u>SAMPLE ID.</u>	<u>TEST PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>	<u>MDL</u>	<u>DILUTION</u>	<u>ANALYST</u>	<u>TEST DATE</u>
3512	CLO4-TITRATION	590	mg/l.	5	100	PCT	4/6/99
3513	CLO4-TITRATION	295	mg/l.	5	100	PCT	4/6/99
3514	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/6/99
3515	CLO4-TITRATION	680	mg/l.	5	100	PCT	4/6/99
3516	CLO4-TITRATION	715	mg/l.	5	100	PCT	4/6/99
3517	CLO4-TITRATION	340	mg/l.	5	100	PCT	4/6/99
3518	CLO4-TITRATION	544	mg/l.	5	100	PCT	4/6/99
3519	CLO4-TITRATION	125	mg/l.	5	100	PCT	4/6/99
3520	CLO4-TITRATION	520	mg/l.	5	100	PCT	4/6/99
3521	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/6/99
3522	CLO4-TITRATION	1060	mg/l.	5	100	PCT	4/6/99
3523	CLO4-TITRATION	75	mg/l.	5	100	PCT	4/7/99
3524	CLO4-TITRATION	1080	mg/l.	5	100	PCT	4/7/99
3525	CLO4-TITRATION	1035	mg/l.	5	100	PCT	4/7/99
3526	CLO4-TITRATION	614	mg/l.	5	100	PCT	4/7/99
3527	CLO4-TITRATION	698	mg/l.	5	100	PCT	4/7/99
3528	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/7/99
3529	CLO4-TITRATION	74	mg/l.	5	100	PCT	4/7/99
3530	CLO4-TITRATION	310	mg/l.	5	100	PCT	4/7/99
3531	CLO4-TITRATION	625	mg/l.	5	100	PCT	4/7/99
3532	CLO4-TITRATION	340	mg/l.	5	100	PCT	4/7/99
3533	CLO4-TITRATION	170	mg/l.	5	100	PCT	4/7/99
3534	CLO4-TITRATION	55	mg/l.	5	100	PCT	4/8/99
3535	CLO4-TITRATION	285	mg/l.	5	100	PCT	4/8/99
3536	CLO4-TITRATION	525	mg/l.	5	100	PCT	4/8/99
3537	CLO4-TITRATION	355	mg/l.	5	100	PCT	4/8/99
3538	CLO4-TITRATION	630	mg/l.	5	100	PCT	4/8/99
3539	CLO4-TITRATION	280	mg/l.	5	100	PCT	4/8/99
3551	CLO4-TITRATION	580	mg/l.	5	100	PCT	4/8/99
3552	CLO4-TITRATION	1560	mg/l.	5	100	PCT	4/8/99
3553	CLO4-TITRATION	1680	mg/l.	5	100	PCT	4/8/99
3554	CLO4-TITRATION	820	mg/l.	5	100	PCT	4/8/99
3555	CLO4-TITRATION	825	mg/l.	5	100	PCT	4/8/99
3793	CLO4-TITRATION	3280	mg/l.	5	100	PCT	4/9/99
TRC-01	CLO4-TITRATION	970	mg/l.	5	100	PCT	4/9/99
TRC-02	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/9/99
TRC-03	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/9/99
TRC-04	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/9/99
TRC-05	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/9/99
BLANK	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/9/99
LCS-01	CLO4-TITRATION	90	mg/l.	5	100	PCT	4/9/99
LCS-02	CLO4-TITRATION	105	mg/l.	5	100	PCT	4/9/99
TRC-06	CLO4-TITRATION	475	mg/l.	5	100	PCT	4/9/99
TRC-07	CLO4-TITRATION	820	mg/l.	5	100	PCT	4/9/99
TRC-08	CLO4-TITRATION	630	mg/l.	5	100	PCT	4/9/99
TRC-09	CLO4-TITRATION	<50	mg/l.	5	100	PCT	4/9/99
TRC-10	CLO4-TITRATION	155	mg/l.	5	100	PCT	4/9/99
TRC-11	CLO4-TITRATION	320	mg/l.	5	100	PCT	4/9/99

TABLE 2
PERCHLORATE ION-SELECTIVE ELECTRODE RESULTS

<u>SAMPLE ID.</u>	<u>TEST PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>	<u>MDL</u>	<u>DILUTION</u>	<u>ANALYST</u>	<u>TEST DATE</u>
3512	CLO4-SEL-ION	450	mg/l.	100	100	PCT	4/6/99
3513	CLO4-SEL-ION	345	mg/l.	100	100	PCT	4/6/99
3514	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/6/99
3515	CLO4-SEL-ION	820	mg/l.	100	100	PCT	4/6/99
3516	CLO4-SEL-ION	650	mg/l.	100	100	PCT	4/6/99
3517	CLO4-SEL-ION	280	mg/l.	100	100	PCT	4/6/99
3518	CLO4-SEL-ION	620	mg/l.	100	100	PCT	4/6/99
3519	CLO4-SEL-ION	175	mg/l.	100	100	PCT	4/6/99
3520	CLO4-SEL-ION	440	mg/l.	100	100	PCT	4/6/99
3521	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/6/99
3522	CLO4-SEL-ION	880	mg/l.	100	100	PCT	4/6/99
3523	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/7/99
3524	CLO4-SEL-ION	1240	mg/l.	100	100	PCT	4/7/99
3525	CLO4-SEL-ION	1120	mg/l.	100	100	PCT	4/7/99
3526	CLO4-SEL-ION	675	mg/l.	100	100	PCT	4/7/99
3527	CLO4-SEL-ION	640	mg/l.	100	100	PCT	4/7/99
3528	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/7/99
3529	CLO4-SEL-ION	110	mg/l.	100	100	PCT	4/7/99
3530	CLO4-SEL-ION	280	mg/l.	100	100	PCT	4/7/99
3531	CLO4-SEL-ION	670	mg/l.	100	100	PCT	4/7/99
3532	CLO4-SEL-ION	400	mg/l.	100	100	PCT	4/7/99
3533	CLO4-SEL-ION	155	mg/l.	100	100	PCT	4/7/99
3534	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/8/99
3535	CLO4-SEL-ION	345	mg/l.	100	100	PCT	4/8/99
3536	CLO4-SEL-ION	440	mg/l.	100	100	PCT	4/8/99
3537	CLO4-SEL-ION	350	mg/l.	100	100	PCT	4/8/99
3538	CLO4-SEL-ION	660	mg/l.	100	100	PCT	4/8/99
3539	CLO4-SEL-ION	330	mg/l.	100	100	PCT	4/8/99
3551	CLO4-SEL-ION	525	mg/l.	100	100	PCT	4/8/99
3552	CLO4-SEL-ION	1880	mg/l.	100	100	PCT	4/8/99
3553	CLO4-SEL-ION	1755	mg/l.	100	100	PCT	4/8/99
3554	CLO4-SEL-ION	910	mg/l.	100	100	PCT	4/8/99
3555	CLO4-SEL-ION	775	mg/l.	100	100	PCT	4/8/99
3793	CLO4-SEL-ION	3450	mg/l.	100	100	PCT	4/9/99
BLANK	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
LCS-01	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/8/99
LCS-02	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
TRC-01	CLO4-SEL-ION	970	mg/l.	100	100	PCT	4/9/99
TRC-02	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
TRC-03	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
TRC-04	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
TRC-05	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
TRC-06	CLO4-SEL-ION	535	mg/l.	100	100	PCT	4/9/99
TRC-07	CLO4-SEL-ION	880	mg/l.	100	100	PCT	4/9/99
TRC-08	CLO4-SEL-ION	675	mg/l.	100	100	PCT	4/9/99
TRC-09	CLO4-SEL-ION	<100	mg/l.	100	100	PCT	4/9/99
TRC-10	CLO4-SEL-ION	105	mg/l.	100	100	PCT	4/9/99
TRC-11	CLO4-SEL-ION	415	mg/l.	100	100	PCT	4/9/99

Ship To: <u>CTS</u> Attn: <u>23441 GOLDEN Spr. 22</u> <u>Diamond BAR, CA</u>					Page <u>1</u> of <u>4</u> Project Name: <u>PERCULANTE</u> Project No.: <u>98-346</u> Site Location: <u> </u> Date: <u>3/16/99</u>					CHAIN OF CUSTODY RECORD																					
					<div style="border: 1px solid black; padding: 5px; transform: rotate(-45deg); display: inline-block;"> Analysis </div>																										
Boring/Well No.	Sample No.	Depth	Date	Time	Sample Type			Comp.	Grab.	Sample Containers												Remarks									
					Water	Solid	Other			Vol.	No.	Type	Pres.																		
3512						✓																									
3513						✓																									
3514						✓																									
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Special Instructions / Shipment / Handling / Storage Requirements: <u>Call R. Scott for INSTRUCTIONS</u>																						<input checked="" type="checkbox"/> TRC 21 Technology Drive Irvine, California 92618 (949) 727-9336									
The material(s) listed are received for analysis and/or treatability evaluation and remain the property of the client and not TRC. At the conclusion of the test work, all remaining material(s) will be returned to the client for eventual disposal at a licensed facility.																						<input type="checkbox"/> TRC 2815 Mitchell Drive, Suite 103 Walnut Creek, California 94598 (925) 935-3294									

Ship To: <u>CTS</u> Attn: _____ _____ _____ _____					Page <u>2</u> of <u>4</u> Project Name: <u>PERC</u> Project No.: <u>98-346</u> Site Location: _____ Date: <u>3, 16, 99</u>					CHAIN OF CUSTODY RECORD <div style="border: 1px solid black; padding: 5px; margin: 5px auto; width: 80%;"> Analysis </div>													
Boring/Well No.	Sample No.	Depth	Date	Time	Sample Type			Comp.	Grab.	Sample Containers												Remarks	
					Water	Solid	Other			Vol.	No.	Type	Pres.										
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3529						✓								✓									
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The material(s) listed are received for analysis and/or treatability evaluation and remain the property of the client and not TRC. At the conclusion of the test work, all remaining material(s) will be returned to the client for eventual disposal at a licensed facility.																							
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Ship To: <u>CTS</u> Attn: _____ _____ _____					Page <u>3</u> of <u>4</u> Project Name: <u>PERC</u> Project No.: <u>99-3416</u> Site Location: _____ Date: <u>3, 16, 99</u>					CHAIN OF CUSTODY RECORD																			
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															(Diagonal lines indicating analysis)														
Boring/Well No.	Sample No.	Depth	Date	Time	Sample Type			Comp.	Grab.	Sample Containers				Remarks															
					Water	Solid	Other			Vol.	No.	Type	Pres.																
3553						✓									✓														
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3555						✓									✓														
3793						✓									✓														
TRC-01						✓									✓														
TRC-02						✓									✓														
TRC-03						✓									✓														
TRC-04						✓									✓														
TRC-05						✓									✓														
BLANK						✓									✓														
LCS-1						✓									✓														
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TRC-06						✓									✓														
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ATTACHMENT 1
DETERMINATION OF PERCHLORATE
BY ION-CHROMATOGRAPHY

TRC

METHOD STATUS: APPROVED FOR ROUTINE USE

METHOD REVISION NO.: 0

Shamshir Kumar Rishi
Public Health Chemist
S. Kumar Rishi
SRLB Northern Section Chief

Harold S. Okamoto
Environmental Biochemist
H. S. Okamoto
SRLB Branch Chief

DETERMINATION OF PERCHLORATE
BY ION CHROMATOGRAPHY

1. Scope and Application

- 1.1 This method covers the determination of the perchlorate anion by ion chromatography.
- 1.2 The applicable matrices are shown below.
 - 1.2.1 Drinking water, groundwater and reagent waters: This method has been found to perform adequately on water samples with conductivities up to 1000 $\mu\text{mhos/cm}$. Water samples with conductivities >1000 $\mu\text{mhos/cm}$ have not been tested.
 - 1.2.2 Although not specifically tested, this method is potentially applicable to surface water, mixed domestic water, and industrial wastewaters. See also Sect. 1.7.
- 1.3 The Method Detection Limit (MDL defined in Sect. 3.10) and Reporting Limit (RL defined in Sect. 3.12) for perchlorate in reagent water is 0.7 $\mu\text{g/L}$ (pooled data) and 4.0 $\mu\text{g/L}$, respectively. See Table 1. The MDL and RL for a specific matrix may differ from that listed, depending upon the nature of the sample.
- 1.4 The linear calibration range for perchlorate is approximately 2.5 to 500 $\mu\text{g/L}$. Sample concentrations higher than the upper calibration limit should be diluted with reagent water to a concentration within the calibration range and reanalyzed.
- 1.5 Figure 1 shows the chromatograms for 4 $\mu\text{g/L}$ of perchlorate added to reagent water and a groundwater sample.
- 1.6 This method is recommended for use by analysts experienced in the use of ion chromatography and in the interpretation of the resulting ion chromatograms.
- 1.7 When this method is used to analyze unfamiliar samples, perchlorate identification should be supported by the use of a fortified sample matrix. The fortification procedure is described in Sect. 11.6.
- 1.8 Users of the method data should state the data-quality objectives prior to analysis. Users of the method must demonstrate the ability to generate acceptable results with this method, using the procedures described in Sect. 9.

- 1.9 **DISCLAIMER** Mention of trade names or commercial products does not constitute endorsement or recommendation for use. Equivalent product substitutions may be made by laboratories using this method as a reference.

2. **Summary of Method**

- 2.1 A fixed volume of sample is injected into an ion chromatographic system, where the perchlorate anion is separated from other interfering anions and quantified.
- 2.2 To detect perchlorate in the low ppb ($\mu\text{g/L}$) range without sample preconcentration, a high volume sample loop is used.
- 2.3 To minimize hydrophobic interaction of the perchlorate anion with the anion exchange support resin, p-cyanophenol is added to the eluent to deactivate the active sites on the resin. Without column deactivation, the perchlorate peak elutes with a longer retention time, is broader (isocratic elution), and tails severely, thus resulting in poor peak detection as the perchlorate sample concentration decreases.

3. **Definitions**

- 3.1 **CALIBRATION BLANK (CB)** – A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.
- 3.2 **CALIBRATION STANDARD (CAL)** – A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.
- 3.3 **FIELD DUPLICATES (FD)** – Two separate samples collected at the same time and location under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of field duplicates indicate the precision associated with sample collection, preservation and storage, as well as with laboratory procedures.
- 3.4 **INSTRUMENT PERFORMANCE CHECK SOLUTION (IPC)** – A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.
- 3.5 **LABORATORY FORTIFIED BLANK (LFB)** – An aliquot of reagent water or other blank matrices to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the method is in control, and whether the laboratory is capable of making accurate and precise measurements.
- 3.6 **LABORATORY FORTIFIED SAMPLE MATRIX (LFM)** – An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

- 3.7 **LABORATORY REAGENT BLANK (LRB)** -- An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.
- 3.8 **LINEAR CALIBRATION RANGE (LCR)** -- The concentration range over which the instrument response is linear.
- 3.9 **MATERIAL SAFETY DATA SHEET (MSDS)** -- Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.
- 3.10 **METHOD DETECTION LIMIT (MDL)** -- The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero. (See Ref. 16.3.)
- 3.11 **QUALITY CONTROL SAMPLE (QCS)** -- A solution of method analyte(s) of known concentration(s) that is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.
- 3.12 **REPORTING LIMIT (RL)** -- The reporting limit used in this method is defined as the minimum quantifiable concentration level at which a sample concentration result may be reported and is equal to five times the MDL.

4. Interferences

- 4.1 Interferences can be caused by substances with retention times that are similar to and overlap the anion of interest. High concentrations of an anion can interfere with the peak resolution of an adjacent anion. Sample dilution and/or fortification can be used to solve most interference problems associated with retention times.
- 4.2 The large water dip or negative peak is due to the large aliquot of sample injected onto the column. However, the perchlorate anion is retained for a sufficient length of time in the column and elutes free of interference from the water dip.
- 4.3 Due to the strength of the eluant, the majority of the anions in a water sample will elute soon after the water dip. Because of the large sample volume injected, the detector response from these anions may be very high, depending on the amount of dissolved solids present in the sample. With the longer retention time, the perchlorate anion elutes on the tail end of these early eluting anions and therefore, the detection and quantification of perchlorate is largely unaffected. See Figure 1.
- 4.4 Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baseline in ion chromatograms.

- 4.5 Samples that contain particles larger than 0.45 microns and reagents solutions that contain particles larger than 0.20 microns require filtration to prevent damage to instrument columns and flow systems.

5. Safety

- 5.1 The toxicity or carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Cautions are included for known extremely hazardous materials or procedures.
- 5.2 Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of Material Safety Data Sheets (MSDS) should be made available to all personnel involved in the chemical analysis. The preparation of a formal safety plan is also advisable.
- 5.3 The following chemicals have the potential to be highly toxic or hazardous. The MSDS for each chemical should be consulted.
- 5.3.1 Sodium hydroxide (Sect. 7.2).
- 5.3.2 Sulfuric acid (Sect. 7.3).
- 5.3.3 Potassium perchlorate (Sect. 7.4).

6. Equipment and Supplies

- 6.1 Balance – Analytical, capable of accurately weighing to the nearest 0.1 mg.
- 6.2 Ion chromatograph – Analytical system complete with ion chromatograph and all required accessories including syringes, analytical columns, compressed gasses and detectors.
- 6.3 Sample loop: approximately 740 μ L (12' x 0.02" I.D. tubing).
- 6.4 Anion guard column: Dionex IonPac AG5 (P/N 35396), or equivalent.
- 6.5 Anion separator column: Dionex IonPac AS5 (P/N 35395), or equivalent. This column produces the separation shown in Figure 1.
- 6.6 Anion suppressor device: Dionex AMMS-II (P/N 43074) suppressor system, or equivalent.
- 6.7 Conductivity detector – Dionex CDM-II, or equivalent.
- 6.8 Chromatography data system: The data presented in this method were generated using the Dionex ACH computer interface and the Dionex AI-450 Data Chromatography Software. An equivalent data collection and chromatography processing system may also be used.
- 6.9 Sample bottles: polyethylene, 125 mL, or larger.

7. Reagents and Standards

- 7.1 Reagent water: Distilled or deionized water, free of the anion of interest. The reagent water should contain particles no larger than 0.20 μm .
- 7.2 Eluent solution: 50% (w/w) Sodium hydroxide (CASRN 1310-73-2) 120 mM, p-cyanophenol (CASRN 767-00-0) 2.0 mM. Dissolve 19.20 g of 50% (w/w) sodium hydroxide (NaOH) and 0.4765 g of p-cyanophenol ($\text{NCC}_6\text{H}_4\text{OH}$, 95%, Aldrich P/N C9,400-9, or equivalent) in degassed reagent water and dilute to 2 L. The 50% (w/w) NaOH should be fresh with minimal contamination from dissolved CO_2 (carbonate formation).
- 7.3 Regenerant solution (micro-membrane suppressor): Sulfuric acid (CASRN 7664-93-9) 0.035N. Dilute 3.9 mL reagent grade conc. sulfuric acid (H_2SO_4) to 4 L with reagent water.
- 7.4 Stock standard perchlorate solutions, 1000 mg/L (1 mg/mL): The stock standard solution is prepared from ACS reagent grade material. Dissolve 1.3931 g potassium perchlorate (KClO_4 , CASRN 7778-74-7) in reagent water and dilute to 1 L.
- 7.4.1 Prepare a 1000 mg/L perchlorate (KClO_4) stock solution for use in preparing the instrument calibration solutions and IPC solutions.
- 7.4.2 Prepare a 1000 mg/L perchlorate stock solution using a material source different from that of the calibration stock for use in preparing the QCS, LFB and LFM. The QCS is used to verify the accuracy of the instrument calibration.
- 7.4.3 The analyst should be aware of the purity of the potassium perchlorate used to prepare the stock standard. A weight correction must be made when the solid material is less than 99% pure.
- 7.5 Intermediate stock standard perchlorate solutions. Prepare 10, 1.0 and 0.10 mg/L standard solutions from the stock standard solutions.

NOTE: Stability of standards: The stock standard is stable for at least one month when stored at 4°C. The intermediate stock and dilute working standards should be prepared weekly.

8. Sample Collection, Preservation and Storage

- 8.1 Samples should be collected in plastic or glass bottles. All bottles must be thoroughly cleaned and rinsed with reagent water. Volume collected should be sufficient to insure a representative sample, allow for replicate analysis, if required, and minimize waste disposal.
- 8.2 Sample preservation and holding time for perchlorate determined by this method are as follows:

<u>Analyte</u>	<u>Preservation</u>	<u>Holding Time</u>
Perchlorate	Store at 4°C	28 days

* Note: Based on the stability of chlorate. Under the same conditions, the stability of perchlorate is expected to be equivalent to, or more stable than, chlorate.

9. Quality Control

9.1 Each laboratory using this method is required to operate a formal quality control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability, and the periodic analysis of laboratory reagent blanks, fortified blanks and other laboratory solutions as a continuing check on performance. The laboratory is required to maintain performance records that define the quality of the data that are generated.

9.2 Initial Demonstration of Performance

9.2.1 The initial demonstration of performance is used to characterize instrument performance (determination of LCRs and analysis of QCS) and laboratory performance (determination of MDL) prior to performing analyses by this method.

9.2.2 Linear Calibration Range (LCR) -- The LCR must be determined initially and verified every six months or whenever a significant change in instrument response is observed or expected. The initial demonstration of linearity must use sufficient standards to insure that the resulting curve is linear. The verification of linearity must use a minimum of a blank and three standards. If any verification data exceeds the initial values by $\pm 10\%$, linearity must be reestablished. If any portion of the range is shown to be nonlinear, sufficient standards must be used to clearly define the nonlinear portion.

9.2.3 Quality Control Sample (QCS) -- When beginning the use of this method, on a quarterly basis or as required to meet data-quality needs, verify the calibration standards and acceptable instrument performance with the preparation and analyses of a QCS. If the determined concentrations are not within $\pm 10\%$ of the stated values, performance of the determinative step of the method is unacceptable. The source of the problem must be identified and corrected before either proceeding with the initial determination of MDLs or continuing with on-going analyses.

9.2.4 Method Detection Limit (MDL) -- The MDL must be established for the analyte, using reagent water (blank) fortified at a concentration of two to three times the estimated instrument detection limit (Ref. 16.3). To determine the MDL value, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = (t) \times (S)$$

where, t = Student's t value for a 99% confidence level and a standard deviation estimate with $n-1$ degrees of freedom [$t = 3.14$ for seven replicates].

S = standard deviation of the replicate analyses.

MDLs should be determined every year, when a new operator begins work or whenever there is a significant change in the background or instrument response.

9.3 Assessing Laboratory Performance

9.3.1 Laboratory Reagent Blank (LRB) -- The laboratory must analyze at least one LRB with each batch of samples. Data produced are used to assess contamination from the laboratory environment. Values that exceed the MDL indicate that laboratory or reagent contamination should be suspected and corrective action must be taken before continuing the analysis.

9.3.2 Laboratory Fortified Blank (LFB) -- The laboratory must analyze at least one LFB with each batch of samples. Calculate accuracy as percent recovery (Sect. 9.4.1.2). If the recovery of perchlorate falls outside the required control limits of 90-110%, perchlorate is judged out of control, and the source of the problem should be identified and resolved before continuing with the analysis.

9.3.2.1 The laboratory must use LFB analyses data to assess laboratory performance against the required control limits of 90-110%. When sufficient internal performance data become available (usually a minimum of 20-30 analyses), optional control limits can be developed from the percent mean recovery (\bar{x}) and the standard deviation (S) of the mean recovery. These data can be used to establish the upper and lower control limits as follows:

$$\text{UPPER CONTROL LIMIT} = \bar{x} + 3S$$

$$\text{LOWER CONTROL LIMIT} = \bar{x} - 3S$$

9.3.2.2 The optional control limits must be equal to or better than the required control limits of 90-110%. After each five to ten new recovery measurements, new control limits can be calculated using only the most recent 20-30 data points. Also, the standard deviation (S) data should be used to establish an on-going precision statement for the level of concentrations included in the LFB. These data must be kept on file and be available for review.

9.3.2.3 Replicates of LFBs should be analyzed quarterly, or sooner, to determine the precision of the laboratory measurements. Add these results to the on-going control charts to document data quality.

9.3.3 Instrument Performance Check Solution (IPC) -- For all determinations the laboratory must analyze the IPC (a midrange check standard) and a calibration blank immediately following daily calibration, after every tenth sample (or more frequently, if required) and at the end of the sample run. Analysis of the IPC solution and calibration blank immediately following calibration must verify that the instrument is within $\pm 10\%$ of calibration. Subsequent analyses of the IPC solution must verify the calibration is still within $\pm 10\%$. If the calibration cannot be verified within the specified limits, reanalyze the IPC solution. If the second analysis of the IPC solution confirms calibration to be outside the limits, sample analysis must be

discontinued, the cause determined and/or in the case of drift, the instrument recalibrated. All samples following the last acceptable IPC solution must be reanalyzed. The analysis data of the calibration blank and IPC solution must be kept on file with the sample analyses data.

9.4 Assessing Analyte Recovery and Data Quality

9.4.1 Laboratory Fortified Sample Matrix (LFM) – The laboratory must perform a matrix spike on a minimum of 10% of the routine samples. In each case the LFM aliquot must be a duplicate of the aliquot used for sample analysis. The spiked perchlorate concentration must be high enough to be detected above the original sample concentration and should not be less than five times the MDL. The added perchlorate concentration should be the same as that used in the LFB.

9.4.1.1 In a blind matrix spike, if the concentration of fortification is less than 25% of the background concentration of the matrix the matrix recovery should not be calculated.

9.4.1.2 Calculate the percent recovery for perchlorate, corrected for the concentration measured in the unfortified sample, and compare the value to the initial LFM recovery range of 75-125%. Percent recovery may be calculated using the following equation:

$$R = \frac{C_A - C}{A} \times 100\%$$

where,

R = percent recovery.

C_A = fortified sample concentration.

C = sample background concentration.

A = concentration equivalent of analyte added to sample.

9.4.1.3 When sufficient internal performance data becomes available (a minimum of 20 analyses) develop control limits from percent mean recovery (X) and the standard deviation (S) of the mean recovery, as in Sect. 9.3.2.1.

9.4.1.4 If the recovery of the analyte falls outside the designated LFM recovery range and the laboratory performance for that analyte is shown to be in control (Sect. 9.3), the recovery problem encountered with the LFM is judged to be either matrix or solution related, not system related.

9.4.2 Where reference materials are available, they should be analyzed to provide additional performance data. The analysis of reference samples is a valuable tool for demonstrating the ability to perform the method acceptably.

9.4.3 In recognition of the rapid advances occurring in chromatography, the analyst is permitted certain options, such as the use of an anion concentrator column, different columns and/or eluents, to improve the separation, quantification, or lower the cost of measurements. Each time

such modifications to the method are made, the analyst is required to repeat the procedure in Sect. 9.

- 9.4.4 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Field duplicates may be analyzed to monitor the precision of the sampling technique. When doubt exists over the identification of a peak in the chromatogram, confirmatory techniques such as sample dilution and fortification, must be used. Whenever possible, the laboratory should perform analysis of quality control check samples and participate in relevant performance evaluation sample studies.

10. Calibration and Standardization

- 10.1 Establish ion chromatographic operating parameters equivalent to those indicated in Table 1.
- 10.2 Prepare calibration standards at a minimum of five concentration levels and a blank by adding accurately measured volumes of one or more intermediate stock standards (Sect. 7.5) to a volumetric flask and diluting to volume with reagent water. Perform a full instrument calibration on a monthly basis, or whenever a significant change in instrument response is observed or expected.
- 10.2.1 During this procedure, the perchlorate retention time must be recorded.
- 10.2.2 To confirm the linearity of the calibration curve, the predicted concentration for each calibration standard should be calculated by using the established linear regression curve and response from each standard concentration. If the predicted response for any standard varies from the expected response by more than $\pm 10\%$, perform corrective action.
- 10.3 The calibration curve must be verified by analyzing the IPC solutions on each working day, or whenever the anion eluent is changed, and after every 20 samples. If the response or retention time for perchlorate varies from the expected values by more than $\pm 10\%$, the test must be repeated, using fresh IPC solutions. If the results are still more than $\pm 10\%$, a new calibration curve must be prepared.
- 10.4 Nonlinear response can result when the analytical column capacity is exceeded (overloading). The response of the detector to the sample when diluted 1:1, and when not diluted, should be compared. If the calculated responses are the same, the sample need not be diluted.

11. Procedure

- 11.1 Table 1 summarizes the recommended operating conditions for the ion chromatograph. Included in the table is the estimated retention time that can be achieved by this method.
- 11.2 Check the system calibration daily and, if required, recalibrate as described in Sect. 10.
- 11.3 Analyze the IPCs, QCS, LRB, samples, LFB, LFM, and blanks.

- 11.4 The width of the retention time window used to make the perchlorate identification should be based upon measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time can be used to calculate a suggested window size. However, the experience of the analyst should weigh heavily in the interpretation of chromatograms.
- 11.5 If a sample concentration exceeds the calibration range, the sample must be diluted with reagent water to fall within the working range.
- 11.6 If the resulting chromatogram fails to produce adequate resolution, or if identification of the specific anion is questionable, fortify the sample with an appropriate amount of standard and reanalyze.

NOTE: Retention time is inversely proportional to concentration. In some cases this peak migration may produce poor resolution or identification.

12. Data Analysis and Calculations

- 12.1 Peak integration may be performed using either the peak height or the peak area method. However, the method of peak height is frequently preferable to the method of peak area, as the peak height determination is generally less affected by baseline placement as compared to the peak area determination.
- 12.2 Examine the chromatograms for perchlorate baselines set by the parameters used in the chromatography method. Correct any baseline improperly set by the method by modifying the integration parameters in the method. Save the corrected baseline to the raw data file.
- 12.3 As a check on system performance, the response for a low concentration standard (e.g. 4 µg/L perchlorate standard solution) should be monitored and recorded. If the daily detector response is more than three standard deviations lower than the recorded mean response, perform corrective action.
- 12.4 Prepare the calibration curve by plotting the instrument response against the standard concentration. Compute the sample concentration (corrected for any sample dilution) by comparing the sample response with the standard curve.
- 12.5 Report only those values that fall between the RL (Table 1) and the highest calibration standard. Samples exceeding the highest standard should be diluted and reanalyzed.
- 12.6 Report the perchlorate results in µg/L.

13. Method Performance

- 13.1 Table 1 gives the single laboratory MDL under the conditions listed.
- 13.2 Tables 2 and 3 give the single laboratory accuracy and precision for perchlorate in reagent water and in groundwater for the listed conditions.
- 13.3 Table 4 gives the single laboratory precision for replicate analyses of perchlorate in groundwater samples.

14. Pollution Prevention

- 14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.
- 14.2 Quantity of the chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.
- 14.3 For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction," available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington D.C. 20036, (202) 872-4477.

15. Waste Management

- 15.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any waste discharge permit and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel," available from the American Chemical Society at the address listed in Sect. 14.3.

16. References

- 16.1 Record 269, Dionex Chromatography Database 4.2.0, Dionex Corp., Sunnyvale, CA, 94086.
- 16.2 Method 300.0, Revision 2.1, "Determination of Inorganic Anions by Ion Chromatography," August 1993, Environmental Monitoring Systems Laboratory, Office of Research and Development, USEPA, Cincinnati, OH, 45268.
- 16.3 Code of Federal Regulations 40, Ch. 1, Part 136, Appendix B.

17. Acknowledgement

This method was developed and compiled by H.S. Okamoto, D.K. Rishi, S.K. Perera and F.J. Baumann of the California Department of Health Services, Division of Drinking Water and Environmental Management, Sanitation and Radiation Laboratories Branch. Technical advice was also generously provided by A. Fitchett, Dionex Corporation, Sunnyvale, California.

FIGURE 1. CHROMATOGRAMS OF 4 $\mu\text{g/L}$ PERCHLORATE ADDED TO REAGENT WATER
AND TO A GROUNDWATER SAMPLE

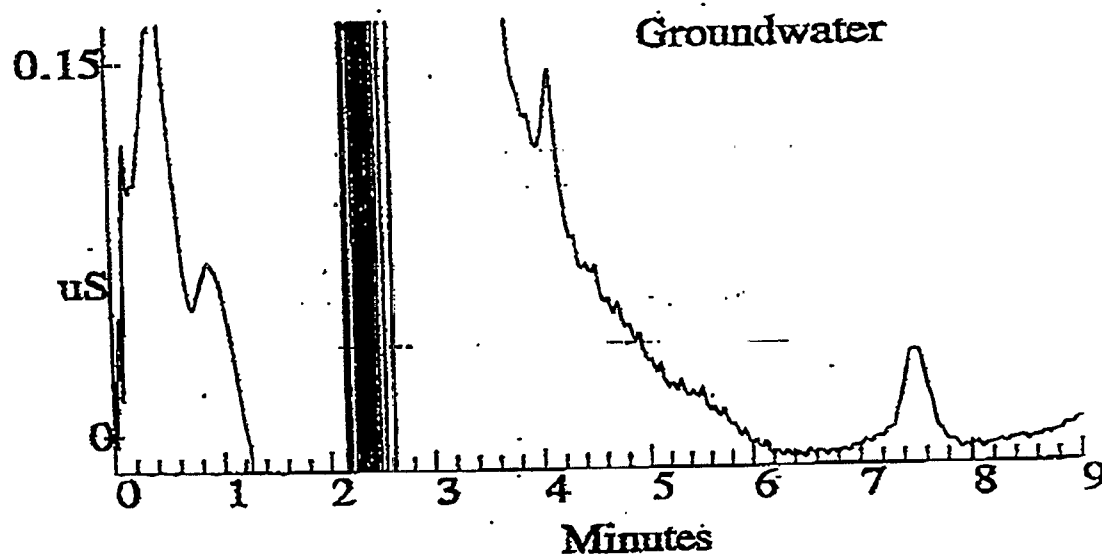
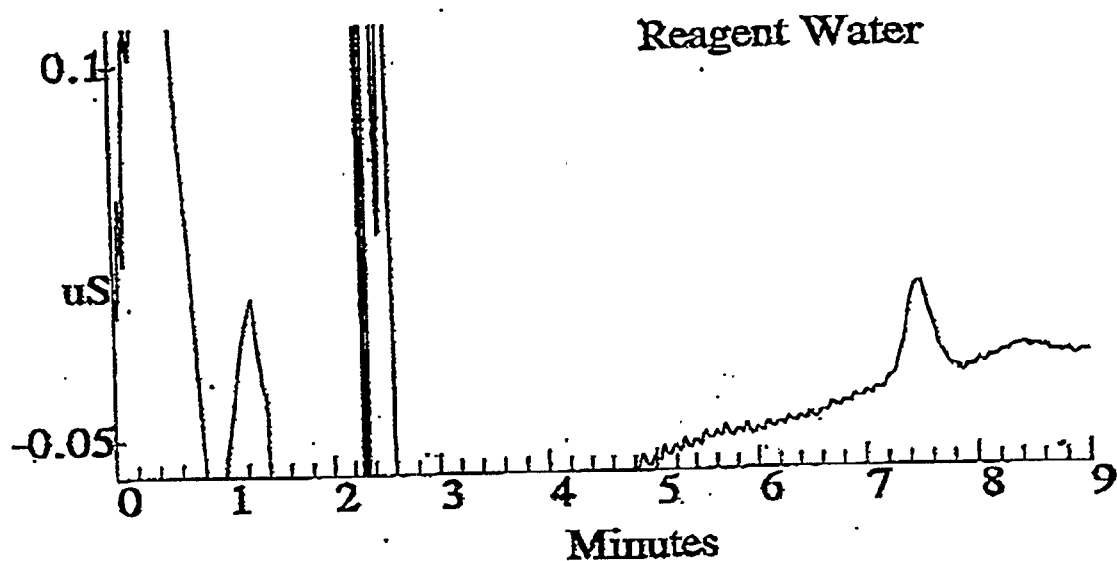


TABLE 1. CHROMATOGRAPHIC CONDITIONS AND DETECTION LIMIT IN REAGENT WATER

Perchlorate Spike Conc. (µg/L)	No. of Spiked Replicates	Mean Perchlorate Recovery (µg/L)	Standard Deviation (µg/L)	Calculated MDL (µg/L)
1.0	14	0.87	0.11	0.6
2.5	16	2.3	0.12	0.8
4.0	16	3.9	0.11	0.7

Pooled MDL (df = 43)	0.7 µg/L
RL (5 x MDL)	4 µg/L
Retention Time	~ 7.4 min.

Perchlorate peak height response for 4.0 µg/L = 0.04 µS

Equipment and Standard Conditions Used to Produce Data in this Method:

Dionex 4500 Ion Chromatograph with Autosampler

Detector: Dionex CDM-2

Ion Suppressor: Dionex AMMS-II

Columns: Dionex IonPac AG5 Guard column (P/N 35396)

Dionex IonPac AS5 Analytical (P/N 35395)

Column Temperature: Ambient

Injector Loop: 740 µL (approximate volume)

Eluent: 120 mM NaOH + 2.0 mM p-Cyanophenol

Eluent Flow rate: 1.0 mL/min.

Regenerant: 35 mN H₂SO₄

Regenerant Flow rate: 10 mL/min.

Conductivity Detector Background Reading: <12 µS

TABLE 2. SINGLE-OPERATOR ACCURACY AND PRECISION FOR PERCHLORATE STANDARD SOLUTIONS

Sample Type	Sample Matrix	Known Conc. (µg/L)	Number of Replicates	Mean Recovery		SD (µg/L)	RSD (%)
				(µg/L)	(%)		
IPC Standard	RW	5.0	48	4.9	98	0.35	7.1
		100	47	100	100	4.2	4.2
QCS	RW	4.0	16	4.0	100	0.31	7.8
		100	4	100	100	2.8	2.8
LFB	RW	4.0	22	3.9	98	0.33	8.5

RW = reagent water

TABLE 3. SINGLE-OPERATOR ACCURACY AND PRECISION FOR PERCHLORATE MATRIX SPIKES

Sample Type	Sample Matrix	Spike Conc. (µg/L)	Number of Spiked Pairs	Duplicate-Spike Mean Recovery		Mean RPD (%)	SD of Mean RPD (%)
				(µg/L)	(%)		
Matrix Spike/ Matrix Spike Duplicate	GW	4.0	20	3.8	95	2.1	0.02

GW = groundwater

TABLE 4. SINGLE-OPERATOR PRECISION FOR PERCHLORATE SAMPLE REPLICATES

Sample Type	Sample Matrix	Number of Replicate Pairs**	Mean RPD (%)	SD of Mean RPD (%)
Sample/Sample Duplicate	GW	14	1.4	0.02

GW = groundwater

**Note: Samples with perchlorate concentration ≥ 4.0 µg/L